Conservation and Renewables Discount

Technical Specifications

Energy Efficiency
Bonneville Power Administration

October 1, 2004

Conservation and Renewables Residential Specifications
October 1, 2004

Index to Sections

Note: The specifications in bold have been updated from the October 1, 2003 versions. The changes are underlined in the specification document, to help you identify what has been added or clarified.

Conservation and Renewables Discount Program
Specification Changes for FY2005

RTF Air Source Heat Pump - Appendix H

Section	Summary	New Spec	Old Spec
No changes were made to these specifications			

RTF Air-Source Heat Pump System Installation Standards[1]

October 1, 2003

[1] These standards have been revised from those orginally developed by the Umatilla Electric Cooperative.

1.0 INTRODUCTION

1.1 "Should and Shall" will be interpreted as follows:

1.1.1 Where shall or shall not is used for a provision, that provision is mandatory if compliance with the standard is claimed.

1.1.2 Where should is used it will indicate provisions which are not mandatory but which are desirable as good practice.

2.0 EQUIPMENT REQUIREMENTS

2.1 Approved Manufacturer

Equipment shall be manufactured by a company appearing in the ARI Unitary Directory.

2.2 Ratings

Heat pump equipment shall meet the performance, safety, and rating requirements as given in the latest revision of Air Conditioning and Refrigeration Institute (ARI) Standard 240. Units shall be listed by Underwriters' Laboratories, or equal and shall display the ARI symbol of certification.

2.3 Performance

Site Built Housing - Air Source Heat Pumps shall be either ENERGY STAR labeled, or have an HSPF rating of not less than 8.0 for split systems or 7.6 for package units and SEER ratings of not less than 13.0 for split systems or 12.0 for packaged units, as certified by ARI. Split systems shall have an EER of not less than 11.0 and packaged systems shall have an EER of not less than 10.5. Ground Source Heat Pumps shall have a C.O.P. rating of not less than 3.0 as certified by ARI.

Manufactured Housing - Air Source Heat Pumps shall be either ENERGY STAR labeled, or have an HSPF rating of not less than 8.0 for split systems or 7.6 for package units and SEER ratings of not less than 12.0 for split systems or packaged units, as certified by ARI. Split systems shall have an EER of not less than 11.0 and packaged systems shall have an EER of not less than 10.5. Ground Source Heat Pumps shall have a C.O.P. rating of not less than 3.0 as certified by ARI.

Under the Conservation and Renewables Discount Program, equipment with lower efficiency ratings than those required above may be installed if the “Heat Pump HSPF and SEER Tradeoff and Deemed Savings Calculator” is used to determine the acceptable efficiencies and associated savings value.

2.4 Protective Devices

Equipment should be provided with a crankcase heater and a liquid-line filter drier. Delay timers to protect against damage from short cycling of the compressor and compressor motor start-assist kits shall be installed when recommended by the manufacturer. The compressor

shall be protected from abnormal operating pressures, temperatures, and loss of refrigerant by suitable pressure or temperature overload devices.

To prevent floodback of liquid refrigerant to the compressor, a suction line accumulator shall be installed, unless not recommended by the manufacturer.

3.0 PARTICIPATING INSTALLER REQUIREMENTS

3.1 Training

Participating Installer shall be responsible for the technical competence and qualifications of his salespeople, installers, and service mechanics. These personnel should participate in at least one manufacturer's training session on heat pump application, installation, or service annually or equivalent training. At least one fourth of all the Participating Installer's installers should be Refrigeration Service Engineers Society (RSES) or North American Technicial Excellence (NATE) heat pump certified or have equivalent certification. At least one System Installer or Technician on each HVAC Contractor job shall be certified in Air Conditioning Contractors of America (ACCA) Manual D. System Designers shall be certified in ACCA Manual D, Manual J and Manual S.

Alternately, duct design, heat pump sizing, and installations may be certified by the utility if the utility has staff that is certified in ACCA's Manual D, Manual J, and Manual S.

3.2 Warranty

The participating Installer shall provide to the consumer in writing the manufacturer's warranty. Heat pump equipment shall be warranted by the manufacturer against defects in material and workmanship for a minimum of five years from the date of start-up of the equipment. In addition, the compressor shall be warranted by the manufacturer against defects in material and workmanship for a minimum of five years from the date of start-up. Warranties shall cover parts and labor. Participating Installers may offer to consumers the manufacturer's extended warranty or service agreement to comply with the warranty requirements.

This warranty should not be considered to cover equipment failure caused by failure to perform normal maintenance, abuse, or external causes beyond the control of the installing Participating Installer.

3.3 Extended Warranty

Participating Installer may offer to all consumers the manufacturer's fifth through tenth year extended warranty or service agreement. This offer shall be made in the proposal.

3.4 Consumer Instruction

Participating Installer shall instruct the consumer in proper operation and maintenance of the heat pump system. Participating Installer shall provide the consumer with the manufacturer's owner's manual, demonstrate filter replacement (or cleaning), and demonstrate the operation of all indoor thermostat controls and indicator lights to the consumer. Participating Installer shall explain to the consumer the different operating modes of the heat pump system (e.g.,

heating, emergency heat, defrost, and the effects of obstructing registers). All this information shall be provided in an operation manual given to the owner.

4.0 EQUIPMENT SELECTION

4.1 Heating and Cooling Calculations

4.1.1 Heating loss and cooling gain calculations shall be made using 70°F indoor design temperature for heating and 75°F for cooling.

4.1.2 The recommended ASHRAE winter design temperature and cooling design temperature for the nearest weather station representative of the installation shall be used.

4.1.3 The recommended method and form for calculations is available in the Air Conditioning Contractors of America (ACCA) Manual J and Manual S. Alternate computer or manual methods of calculating heating and cooling loads may be used if approved in advance by the utility.

4.1.4 Component U-values and F-values used in the heat loss and heat gain coefficients shall reflect the actual construction of the building and be generally consistent with those found in ACCA Manual J 7th Edition, or later.

4.1.5 A copy of the whole house heating and cooling load calculations shall be submitted with the bid. A room-by-room heat loss calculation is recommended as part of the installation but not required.

4.1.6 An infiltration rate of 0.5 air changes/hour shall be used in sizing calculations unless a blower door test is performed and an estimate is made using the result.

4.1.7 Duct system efficiency of 80% shall be used in sizing calculations unless a duct blaster test is performed and an estimate is made using the result.

4.2 Heat Pump System Sizing

The heat pump system shall be sized using either of the following methods, rounding up or down to the nearest 6000 Btu/hr capacity at ARI rating conditions:

1. Heat pumps shall be sized using a 30°F Balance Point
2. Heat pumps shall be sized in accordance with the sizing method specified by the utility.

However, in no case should the Balance Point used for sizing be higher than 35°F. A Balance Point Worksheet shall be submitted with the bid.

4.3 Central Air Conditioner System Sizing

Central air conditioners shall not be sized greater than 140% of design cooling load.

4.4 Supplemental Heater Sizing and Control

Installed auxiliary heating shall not exceed 150% of the heating design load. All supplemental heaters greater than 5 kW should be staged. Supplemental heaters larger than 10 kW shall be staged.

4.5 Outdoor Thermostat

Unless prohibited by the manufacturer, an outdoor thermostat should be installed and set so that auxiliary heating does not engage above 35 ^{o}F, or that temperature required by the utility, except when supplemental or emergency heating is required during a defrost cycle or refrigeration cycle failure. A thermostat equipped with an outdoor temperature sensor may be used in place of an outdoor thermostat if programmed so that auxiliary heating does not engage above 35 ^{o}F, or that temperature required by the utility, except when supplemental or emergency heating is required during a defrost cycle or refrigeration cycle failure.

4.6 Defrost Controls

The system shall have demand defrost controls.

5.0 EQUIPMENT INSTALLATION

5.1 Access

Equipment shall be located to allow easy service access and adequate working space for servicing any component without removal of piping, duct work, or other permanently installed fixtures. Special care shall be taken in locating components which require frequent attention, such as filters.

5.2 Location and Support of Indoor Units

Indoor units shall be located to permit smooth duct transitions and shall be adequately supported or placed in a suitable platform in accordance with manufacturer's instructions and recommendations. Secondary drain pan shall be included in attic installations.

5.3 Location and Support of Outdoor Units

Outdoor units shall be located to avoid restrictions in the outdoor airstream. Units shall be mounted on an adequate, solid, secure pad which provides proper drainage and prevents a buildup of water, snow, or ice. A minimum clearance shall be provided as per manufacturer's instructions and recommendations. In any installation there shall be a minimum of 3 inches of free and clear area under the outdoor coil drainage area. Condensate shall not drain onto areas where ice formation may create a hazard (e.g. walkways).

5.4 Refrigerant Charge

Particpating Installer shall refer to manufacturer’s guidelines when charging system and make any needed adjustments for non-standard line set lengths or mismatched coils. Installer shall use manufacturer’s recommended techniques for verifying performance, including system superheat and subcooling or target pressures at specified temperature and humidity conditions.

6.0 DUCT WORK

6.1 Design Requirements

All new duct work (including the addition of duct systems to existing housing) should be designed and installed in accordance with recommended practice as outlined in Air Conditioning Contractors of America (ACCA) Manual G, "Selection of Distribution Systems"; Manual E, "Room Air Distribution Consideration" and Manual D, "Residential Duct Design and Equipment Selection" or Sheet Metal and Air Conditioning Contractors National Association (SMACNA) "HVAC Duct System Design" or American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) handbooks. Duct sizing calculations and conclusions should be thoroughly documented and provided to the Customer and the Utility. Installation of balancing dampers is recommended.

6.1.1 Flex Duct

Flex duct shall not be used for main supply trunks in crawl spaces or areas that could be subject to physical damage from normal occupant activities, weather or animals. When flex duct is used for main trunks or run outs the size shall be determined by using the "Wire Helix Flexible Duct" scale on an ACCA Duct Sizing Slide Rule, or equivilent and all other requirements in Section 6.0 of these specifications shall be met.

6.1.2 Building Cavities and Ducts

In new housing, building cavities shall not be used as ducts to convey return or supply air. In retrofit applications, use of building cavities is allowed for return air, but it is not recommended.

6.1.3 Static Losses

Supply and return ducts shall be designed on the basis of not more than 0.10 and 0.08 inches loss per 100 feet respectively. Supply and Return Ducts shall be designed so that the total system static pressure does not exceed the available static pressure provided by the air handler at design CFM. Flex duct shall be supported in a manner that does not create restrictions in air flow and located to minimize bending.

6.1.4 Maximum Velocities

New duct work shall be designed so air velocities do not exceed the following:

<u>Supply Ducts</u>

Main Ducts	900 FPM
Branch Ducts	600 FPM
Supply Outlet Face Velocity	700 FPM
Return Grills Face Velocity	500 FPM
Filter Grille Face Velocity	300 FPM

Velocity shall not create unaceptable noise levels and return air shall be sufficient size to meet requirements of installed systems.

6.1.5 Diffusers and Registers

Proper diffusers and registers shall be selected and installed in the proper locations.

6.1.6 Branch Ducts

Branch out runs should be a minimum of 6 inches in diameter except to bathrooms.

6.1.7 Duct Connections

All new and all readily accessible existing duct joints, plenum drives, metal joints to include all slips and drives shall be mechanically fastened with screws. Flexible ducts shall be attached using nylon/plastic straps tightened with a manufacturer approved tool (hand tightening is not acceptable) or stainless steel worm drive clamps. Mastic and/or tape shall not be used as mechanical fasteners.

6.1.8 Zonal Pressure Relief

Sufficient return pathways should be provided bewteen axial zones (e.g. bedrooms) and the main body of the dwelling to limit pressurization of these zones to 3 Pa or less when the system is operating at maximum system airflow. Return pathways include return ducts, pass-through grilles, pressure-relief ducts, or similar devices.

6.2 Duct Installation

6.2.2 Insulation

6.2.2.1 All new rigid metal ducts and plenums and accessible existing rigid metal ductwork outside the heated space shall be insulated to an installed value of at least R-8. A vapor barrier meeting a flame spread rating of 25 or less and smoke developed rating of 50 or less (in accordance with ASTM E-84-88) shall be installed on the outside surface of the insulation.

6.2.2.2 All new ducts and plenums that are internally lined with insulation outside the heated space shall be installed in accordance with SMACNA's Duct Liner Application Standard, Second Edition. The total R-value of this duct work shall be no less than R-8.

6.2.2.3 All flexible HVAC ducts outside the heated space shall have an Air Diffusion Council (ADC) certified minimum R-value of R-8.

6.2.2.4 All HVAC ducts routed within exterior wall cavities shall be insulated to a minimum of R-14 between the duct and the exterior wall sheathing.

6.2.2.5 All duct insulation shall be installed and supported using mechanical fasteners such as permanent plastic straps or nylon twine. Tape is not a

mechanical fastener. Approved tape may be used at insulation seams to provide a continuous barrier.

6.2.3 Air Tightness

All new and all accessible existing HVAC supply and return ducts, air handlers, and plenums inside and outside the heated space shall be sealed at all joints and corners, including prefabricated joints, with approved mastic. UL181A-M or UL181B-M mastic shall be used on rigid metal ducts. UL 181B-M mastic shall be used on flex ducts. It is unnecessary to seal longitudinal seams unless they are damaged. Tape is not allowed except for use on operable doors in the system such as on the air handler.

6.3 System Air Flow

6.3.1 All existing ductwork shall be inspected by the HVAC Contractor for conditions which will affect the efficiency or proper operation of the new heat pump system. It is the Participating Installer's responsibility to ensure existing ductwork is compatible with the equipment that is installed.

6.3.1 The air distribution system design and installation shall be such that air flow across the indoor coil is as specified in the heat pump manufacturer's literature, or is between 375 and 425 cubic feet per minute (CFM) per 12000 BTU/hr output at ARI rating conditions if the manufacturer's literature is not specific.

6.4 Start-up Tests and Measurements

After installation and start-up, total airflow in the heat pump mode (in cubic feet per minute, or CFM) across the heat pump coil shall be measured. This, along with the temperature difference across the coils and outdoor ambient air temperature at the outdoor coil, should be reported to the customer.

The CFM shall be measured with a flow plate, or by combining the temperature rise test with measurement of element voltage and amperage in emergency heat mode and making the needed calculations.

7.0 FILTERS

Air filters shall be installed in the return air system in a location that will be easily accessible to the user for filter servicing and in a position where all return air and outside air will pass through the filters before crossing the indoor coil. Filter types and sizes shall meet the standard manufacturer's instructions and recommendations. Filters that are not an intregal part of the equipment and selected by the manufacturer shall not exceed 400 FPM face velocity. Electronic air cleaners shall be accepted if the total CFM is within the range as specified by the manufactuer. Any filter that exceeds 0.22 inches pressure drop as installed shall not be allowed. Filter types and sizes shall meet the standard manufacturer's instructions and recommendations. No more than 400 feet per minute (FPM) face velocity shall be allowed. Filters should not be installed in crawl spaces.

8.0 NOISE AND VIBRATION ABATEMENT

8.1 Indoor Unit

Permanent means shall be provided to prevent transmission of objectionable noise or vibration generated by the indoor unit in accordance with the manufacturer's instructions and recommendations. Supply and return shall be sound lined a minimum of 4 feet from the air handler, with the exception of manufactured homes.

8.2 Outdoor Unit

Outdoor units shall be located to avoid transmission of objectionable noise to adjacent properties, sleeping areas, or other areas where noise control is critical. Where outdoor units are found to be in violation of state and local noise control ordinances, the Participating Installer shall be responsible for any modifications necessary to reduce noise. Unit base shall not be connected to the foundation.

9.0 REFRIGERANT PIPING

9.1 Materials

Field-supplied refrigerant piping shall be clean, dehydrated, and sealed Types K and L seamless copper tubing or the manufacturer's pre-charged tubing. Fittings shall be wrought copper. Field supplied tubing shall be evacuated to 500 microns and purged and pressure tested as per manufacturer's recommendation; soft solders shall not be permitted.

9.2 Sizing

To maintain oil return to the compressor and avoid inefficiency and capacity loss, refrigeration piping or refrigeration line set shall be sized and installed in accordance with the manufacturer's instructions and recommendations. Piping between the two sections of split units shall not exceed the manufacturer's maximum recommended length, horizontally or vertically, and shall be run parallel to building lines and in a straight and workmanlike manner to prevent oil traps.

9.3 Support

Refrigerant piping shall be properly supported in accordance with manufacturer's specifications, ARI, and UMC (Uniform mechanical Code).

9.4 Penetrations

Refrigerant piping passing through openings in the unit cabinet or the building structure shall be installed to prevent wear or sound generation due to contact with the cabinet or building structure. All penetrations shall be properly sealed.

9.5 Insulation

Suction lines shall be insulated with a minimum of 1/2” thick continuous closed-cell foam rubber. Where insulation is exposed to the elements, it should have a weatherproof covering.

Vapor and liquid lines shall be separated so that heat exchange does not take place. Factory insulated pre-charged lines will be accepted.

9.6 Exposed Piping

All refrigerant piping exposed to possible damage from foot traffic around or near an outdoor unit shall be protected or buried in PVC or other corrosion-resistant pipe, in accordance with the manufacturer's instructions, to prevent damage to piping or pipe insulation or injury to people, and to permit replacement if necessary.

9.7 Leak Testing, Evacuation, and Charging

Factory, as well as field joints, shall be checked and any leaks found shall be repaired. Evacuation and charging shall be done in accordance with the manufacturer's instructions and recommendations and the latest edition of ARI Standard 260-75, 3.5-3.7.

10.0 CONDENSATE PIPING

10.1 Manufacturer's Recommendations

Condensate drain piping shall meet UMC and should be copper, plastic, or other corrosion-resistant material.

10.2 Drains

Condensate drain lines shall be trapped and run to an open drain or outside of the building foundation. Under no circumstances may condensate be drained into a crawl space or direct connected into a sewer line. When indoor units are located in attics, the installation shall include a secondary drain pain to collect condensate when a problem exists in the primary drain line. The secondary drain pan shall be connected to a drain line that will drip at a location that will draw attention to the problem in the primary drain line.

10.3 Condensate Pump

Condensate drain lines shall be pitched in the direction of flow to prevent backup of overflow of water in the drain pan. If the indoor unit is lower than the floor drain or dry well, a condensate pump shall be installed to pump condensate to the level of the drain or dry well. An automatic control to shut down system in case of pump failure shall be installed. A check valve shall be installed if pump is not equipped with one.

11.0 ELECTRICAL

11.1 Field Wiring

All field wiring, line and low-voltage, shall comply with the manufacturer's recommendations, the National Electrical Code, and all local codes and ordinances.

12.0 INDOOR THERMOSTATS

12.1 Installation

Indoor thermostats should be located and installed according to the manufacturer's instructions and recommendations. Thermostats generally are installed 5 feet off the floor on an inside wall in the return airflow pattern, and where they are not in the sun or any other heat source at any time.

12.2 Thermostat Staging

The first stage of resistance electric heat ("auxiliary stage") shall be controlled by the second stage of the indoor thermostat. Thermostat indicator lights should provide a visible indication when the auxiliary stage or emergency heat are operating.

12.3 Heating and Cooling

Thermostats used for both heating and cooling shall have a manual changeover feature or heating/cooling lockout to prevent cross-cycling between heating and cooling.

12.4 Emergency Heat Relay

All indoor thermostats shall include a manual selector switch to permit all supplemental heaters or the furnace to be energized under control of the indoor thermostat (with the compressor and outdoor thermostats bypassed) when the compressor or refrigerant system is inoperative.

13.0 ADD-ON HEAT PUMP TO GAS, PROPANE OR OIL FURNACE

13.1 Indoor Coil

For an add-on heat pump, the indoor coil shall be installed in the downstream air from the heat exchanger according to the Uniform Mechanical Code. (UMC).

13.2 Furnace Operation

The furnace shall lock out the heat pump when it operates on second-stage heat, unless heat pump manufacturer's special add-on heat pump control permits operation of both.

13.3 Emergency Heat Operation

Emergency heat switch shall activate the furnace and bypass the heat pump.

Conservation and Renewables Discount Program Specification Comparison for FY2005

Air Source Heat Pump - RTF versus PTCS Specifications

Section	RTF Spec	PTCS Spec
2.4	No related spec	Any low ambient compressor cutout control installed may not be set at a temperature greater than 0 degrees.
3.1	No related spec	Each system must be Climate Crafters certified as PTCS for ducts and system. The technician must be certified by Climate Crafters.
4.1.5	Room by room heat loss calculation recommended.	Room by room heat loss calculation required.
4.1.6	The default ACH for the natural infiltration in the heat loss calculation must be 0.5 unless a blower door is used to determine	A blower door must be used to determine the natural infiltration rate used in the heat loss calculations.
4.1.7	The default duct system efficiency used in the heat loss calculation must be 80% unless a duct blaster is used to determine	A duct blaster must be used to determine the duct system efficiency used in the heat loss calculations.
4.2	It is recommended to not allow a balance point higher than 35 degrees. The balance point worksheet must be submitted with the bid.	A balance point higher than 35 degrees may not be used. The balance point worksheet must be submitted to Climate Crafters.
4.4	It is recommended to stage supplemental heaters greater than 5kW.	It is required to stage supplemental heaters greater than 5kW.
4.5	It is recommended to install an Outdoor Thermostat or equivalent.	An outdoor thermostat or equivalent is required.
5.4	Refrigerant charge must be checked using manufacturer's recommendations	Refrigerant charge must be checked using Climate Crafters approved method and results must be reported to Climate Crafters.
6.1	It is recommended to supply duct design calculations to the customer and utility. Balancing dampers are recommended.	It is required to supply duct design calculations to Climate Crafters. Balancing dampers are required.
6.1.2	Use of building cavities as ducts is allowed only in retrofit applications and only for return ductwork.	Use of building cavities as ducts is not allowed.
6.1.8	Means for zonal pressure relief is recommended.	Zonal pressure relief is required.
6.2.3	No testing required for duct tightness.	Ducts must be sealed, tested, and pass an airtightness standard. The results of this test must be submitted to Climate Crafters.
6.4	A flowplate or temperature rise method may be used to test system airflow.	Only a flowplate may be used to test system airflow. Test results must be reported to Climate Crafters. Airflow to each room must also be tested and adjusted if necessary, and reported to Climate Crafters.
12.2	It is recommended that the thermostat have lights indicating auxiliary or emergency heat operation.	It is required that the thermostat have lights indicating auxiliary or emergency heat operation.

Performance Tested Comfort Systems - Air-Source Heat Pump System Installation Standards[1]

October 1, 2003

[1] These standards have been revised from those orginally developed by the Umatilla Electric Cooperative.

1.0 INTRODUCTION

1.1 "Should and Shall" will be interpreted as follows:

1.1.1 Where shall or shall not is used for a provision, that provision is mandatory if compliance with the standard is claimed.

1.1.2 Where should is used it will indicate provisions which are not mandatory but which are desirable as good practice.

2.0 EQUIPMENT REQUIREMENTS

2.1 Approved Manufacturer

Equipment shall be manufactured by a company appearing in the ARI Unitary Directory.

2.2 Ratings

Heat pump equipment shall meet the performance, safety, and rating requirements as given in the latest revision of Air Conditioning and Refrigeration Institute (ARI) Standard 240. Units shall be listed by Underwriters' Laboratories, or equal and shall display the ARI symbol of certification.

2.3 Performance

Site Built Housing - Air Source Heat Pumps shall be either ENERGY STAR labeled, or have an HSPF rating of not less than 8.0 for split systems or 7.6 for package units and SEER ratings of not less than 13.0 for split systems or 12.0 for packaged units, as certified by ARI. Split systems shall have an EER of not less than 11.0 and packaged systems shall have an EER of not less than 10.5. Ground Source Heat Pumps shall have a C.O.P. rating of not less than 3.0 as certified by ARI.

Manufactured Housing - Air Source Heat Pumps shall be either ENERGY STAR labeled, or have an HSPF rating of not less than 8.0 for split systems or 7.6 for package units and SEER ratings of not less than 12.0 for split systems or packaged units, as certified by ARI. Split systems shall have an EER of not less than 11.0 and packaged systems shall have an EER of not less than 10.5. Ground Source Heat Pumps shall have a C.O.P. rating of not less than 3.0 as certified by ARI.

Under the Conservation and Renewables Discount Program, equipment with lower efficiency ratings than those required above may be installed if the “Heat Pump HSPF and SEER Tradeoff and Deemed Savings Calculator” is used to determine the acceptable efficiencies and associated savings value.

2.4 Protective Devices

Equipment should be provided with a crankcase heater and a liquid-line filter drier. Delay timers to protect against damage from short cycling of the compressor and compressor motor start-assist kits shall be installed when recommended by the manufacturer. The compressor

shall be protected from abnormal operating pressures, temperatures, and loss of refrigerant by suitable pressure or temperature overload devices.

If a low ambient temperature compressor cutout option is installed, it shall not cutout the compressor at temperatures above 0°F.

To prevent floodback of liquid refrigerant to the compressor, a suction line accumulator shall be installed, unless not recommended by the manufacturer.

3.0 PARTICIPATING INSTALLER REQUIREMENTS

3.1 Training

Participating Installer shall be responsible for the technical competence and qualifications of his salespeople, installers, and service mechanics. These personnel should participate in at least one manufacturer's training session on heat pump application, installation, or service annually or equivalent training. At least one fourth of all the Participating Installer's installers should be Refrigeration Service Engineers Society (RSES) or North American Technicial Excellence (NATE) heat pump certified or have equivalent certification. At least one System Installer or Technician on each HVAC Contractor job shall be certified in Air Conditioning Contractors of America (ACCA) Manual D. System Designers shall be certified in ACCA Manual D, Manual J and Manual S.

Alternately, duct design, heat pump sizing, and installations may be certified by the utility if the utility has staff that is certified in ACCA's Manual D, Manual J, and Manual S.

Each system installed shall be certified by Climate Crafters as a Performance Tested Comfort System in both duct and heat pump installation. This requires testing by a Climate Crafters certified technician in accordance with Climate Crafters protocols.

3.2 Warranty

The participating Installer shall provide to the consumer in writing the manufacturer's warranty. Heat pump equipment shall be warranted by the manufacturer against defects in material and workmanship for a minimum of five years from the date of start-up of the equipment. In addition, the compressor shall be warranted by the manufacturer against defects in material and workmanship for a minimum of five years from the date of start-up. Warranties shall cover parts and labor. Participating Installers may offer to consumers the manufacturer's extended warranty or service agreement to comply with the warranty requirements.

This warranty should not be considered to cover equipment failure caused by failure to perform normal maintenance, abuse, or external causes beyond the control of the installing Participating Installer.

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Participating Installer may offer to all consumers the manufacturer's fifth through tenth year extended warranty or service agreement. This offer shall be made in the proposal.

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Participating Installer shall instruct the consumer in proper operation and maintenance of the heat pump system. Participating Installer shall provide the consumer with the manufacturer's owner's manual, demonstrate filter replacement (or cleaning), and demonstrate the operation of all indoor thermostat controls and indicator lights to the consumer. Participating Installer shall explain to the consumer the different operating modes of the heat pump system (e.g., heating, emergency heat, defrost, and the effects of obstructing registers). All this information shall be provided in an operation manual given to the owner.

4.0 EQUIPMENT SELECTION

4.1 Heating and Cooling Calculations

4.1.1 Heating loss and cooling gain calculations shall be made using 70°F indoor design temperature for heating and 75°F for cooling.

4.1.2 The recommended ASHRAE winter design temperature and cooling design temperature for the nearest weather station representative of the installation shall be used.

4.1.3 The recommended method and form for calculations is available in the Air Conditioning Contractors of America (ACCA) Manual J and Manual S. Alternate computer or manual methods of calculating heating and cooling loads may be used if approved in advance by the utility.

4.1.4 Component U-values and F-values used in the heat loss and heat gain coefficients shall reflect the actual construction of the building and be generally consistent with those found in ACCA Manual J 7th Edition, or later.

4.1.5 A copy of the whole house heating and cooling load calculations shall be submitted with the bid. A room-by-room heat loss calculation ***shall be submitted with the bid.***

4.1.6 A blower door test shall be performed to determine the proper air infiltration rate to be used in the sizing calculations.

4.1.7 A duct blaster test shall be performed to make an estimate of duct system efficiency to be made in the sizing calculations.

4.2 Heat Pump System Sizing

The heat pump system shall be sized using either of the following methods, rounding up or down to the nearest 6000 Btu/hr capacity at ARI rating conditions:

1. Heat pumps shall be sized using a 30°F Balance Point
2. Heat pumps shall be sized in accordance with the sizing method specified by the utility.

However, in no case ***shall*** the Balance Point used for sizing be higher than 35°F. A Balance Point Worksheet shall be submitted ***to Climate Crafters***.

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Central air conditioners shall not be sized greater than 140% of design cooling load.

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Installed auxiliary heating shall not exceed 150% of the heating design load. All supplemental heaters greater than 5 kW ***shall*** be staged.

4.5 Outdoor Thermostat

An outdoor thermostat ***shall*** be installed and set so that auxiliary heating does not engage above 35 ^{o}F, or that temperature required by the utility, except when supplemental or emergency heating is required during a defrost cycle or refrigeration cycle failure. A thermostat equipped with an outdoor temperature sensor may be used in place of an outdoor thermostat if programmed so that auxiliary heating does not engage above 35 ^{o}F, or that temperature required by the utility, except when supplemental or emergency heating is required during a defrost cycle or refrigeration cycle failure.

4.6 Defrost Controls

The system shall have demand defrost controls.

5.0 EQUIPMENT INSTALLATION

5.1 Access

Equipment shall be located to allow easy service access and adequate working space for servicing any component without removal of piping, duct work, or other permanently installed fixtures. Special care shall be taken in locating components which require frequent attention, such as filters.

5.2 Location and Support of Indoor Units

Indoor units shall be located to permit smooth duct transitions and shall be adequately supported or placed in a suitable platform in accordance with manufacturer's instructions and recommendations. Secondary drain pan shall be included in attic installations.

5.3 Location and Support of Outdoor Units

Outdoor units shall be located to avoid restrictions in the outdoor airstream. Units shall be mounted on an adequate, solid, secure pad which provides proper drainage and prevents a buildup of water, snow, or ice. A minimum clearance shall be provided as per manufacturer's instructions and recommendations. In any installation there shall be a minimum of 3 inches of free and clear area under the outdoor coil drainage area. Condensate shall not drain onto areas where ice formation may create a hazard (e.g. walkways).

5.4 Refrigerant Charge

Particpating Installer shall refer to manufacturer’s guidelines when charging system and make any needed adjustments for non-standard line set lengths or mismatched coils. ***Refrigerant charge shall be checked using Proctor’s CheckMe program, Honeywell’s ACRx handtool, or other approved Climate Crafters methods.***

Results from refrigerant charge tests shall be submitted to Climate Crafters.

6.0 DUCT WORK

6.1 Design Requirements

All new duct work (including the addition of duct systems to existing housing) ***shall*** be designed and installed in accordance with recommended practice as outlined in Air Conditioning Contractors of America (ACCA) Manual G, "Selection of Distribution Systems"; Manual E, "Room Air Distribution Consideration" and Manual D, "Residential Duct Design and Equipment Selection" or Sheet Metal and Air Conditioning Contractors National Association (SMACNA) "HVAC Duct System Design" or American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) handbooks. Duct sizing calculations and conclusions ***shall*** be thoroughly documented and provided to ***Climate Crafters***. Installation of balancing dampers is ***required.***

6.1.1 Flex Duct

Flex duct shall not be used for main supply trunks in crawl spaces or areas that could be subject to physical damage from normal occupant activities, weather or animals. When flex duct is used for main trunks or run outs the size shall be determined by using the "Wire Helix Flexible Duct" scale on an ACCA Duct Sizing Slide Rule, or equivilent and all other requirements in Section 6.0 of these specifications shall be met.

6.1.2 Building Cavities and Ducts

In new housing, building cavities shall not be used as ducts to convey return or supply air. In retrofit applications, use of building cavities is ***not*** allowed for return air.

6.1.3 Static Losses

Supply and return ducts shall be designed on the basis of not more than 0.10 and 0.08 inches loss per 100 feet respectively. Supply and Return Ducts shall be designed so that the total system static pressure does not exceed the available static pressure provided by the air handler at design CFM. Flex duct shall be supported in a manner that does not create restrictions in air flow and located to minimize bending.

6.1.4 Maximum Velocities

New duct work shall be designed so air velocities do not exceed the following:

<u>Supply Ducts</u>

Main Ducts	900 FPM
Branch Ducts	600 FPM
Supply Outlet Face Velocity	700 FPM
Return Grills Face Velocity	500 FPM

Filter Grille Face Velocity	300 FPM

Velocity shall not create unaceptable noise levels and return air shall be sufficient size to meet requirements of installed systems.

6.1.5 Diffusers and Registers

Proper diffusers and registers shall be selected and installed in the proper locations.

6.1.6 Branch Ducts

Branch out runs should be a minimum of 6 inches in diameter except to bathrooms.

6.1.7 Duct Connections

All new and all readily accessible existing duct joints, plenum drives, metal joints to include all slips and drives shall be mechanically fastened with screws. Flexible ducts shall be attached using nylon/plastic straps tightened with a manufacturer approved tool (hand tightening is not acceptable) or stainless steel worm drive clamps. Mastic and/or tape shall not be used as mechanical fasteners.

6.1.8 Zonal Pressure Relief

Sufficient return pathways ***shall*** be provided bewteen axial zones (e.g. bedrooms) and the main body of the dwelling to limit pressurization of these zones to 3 Pa or less when the system is operating at maximum system airflow. Return pathways include return ducts, pass-through grilles, pressure-relief ducts, or similar devices.

6.2 Duct Installation

6.2.2 Insulation

6.2.2.1 All new rigid metal ducts and plenums and accessible existing rigid metal ductwork outside the heated space shall be insulated to an installed value of at least R-8. A vapor barrier meeting a flame spread rating of 25 or less and smoke developed rating of 50 or less (in accordance with ASTM E-84-88) shall be installed on the outside surface of the insulation.

6.2.2.2 All new ducts and plenums that are internally lined with insulation outside the heated space shall be installed in accordance with SMACNA's Duct Liner Application Standard, Second Edition. The total R-value of this duct work shall be no less than R-8.

6.2.2.3 All flexible HVAC ducts outside the heated space shall have an Air Diffusion Council (ADC) certified minimum R-value of R-8.

6.2.2.4 All HVAC ducts routed within exterior wall cavities shall be insulated to a minimum of R-14 between the duct and the exterior wall sheathing.

6.2.2.5 All duct insulation shall be installed and supported using mechanical fasteners such as permanent plastic straps or nylon twine. Tape is not a mechanical fastener. Approved tape may be used at insulation seams to provide a continuous barrier.

6.2.3 Air Tightness

All new and all accessible existing HVAC supply and return ducts, air handlers, and plenums inside and outside the heated space shall be sealed at all joints and corners, including prefabricated joints, with approved mastic. UL181A-M or UL181B-M mastic shall be used on rigid metal ducts. UL 181B-M mastic shall be used on flex ducts. It is unnecessary to seal longitudinal seams unless they are damaged. Tape is not allowed except for use on operable doors in the system such as on the air handler.

Duct leakage shall be tested using a duct blaster and a blower door in accordance with Climate Crafters protocols. Ductwork shall be sealed to at least one of the following standards:

Retrofit

1. ***The duct leakage to the outside (in CFM) at a duct pressure of 50 Pascals shall be less than 10% of the conditioned floor area.***
2. ***A reduction in duct leakage to the outside (in CFM) at a duct pressure of 50 Pascals of 50% or greater shall be acheived.***

New Construction

1. ***The duct leakage to the outside (in CFM) at a duct pressure of 50 Pascals shall be less than 6% of the conditioned floor area.***

Duct leakage tests shall be documented and documentation shall be provided to Climate Crafters.

6.3 System Air Flow

6.3.1 All existing ductwork shall be inspected by the HVAC Contractor for conditions which will affect the efficiency or proper operation of the new heat pump system. It is the Participating Installer's responsibility to ensure existing ductwork is compatible with the equipment that is installed.

6.3.1 The air distribution system design and installation shall be such that air flow across the indoor coil is as specified in the heat pump manufacturer's literature, or is between 375 and 425 cubic feet per minute (CFM) per 12000 BTU/hr output at ARI rating conditions if the manufacturer's literature is not specific.

6.4 Start-up Tests and Measurements

After installation and start-up, total airflow in the heat pump mode (in cubic feet per minute, or CFM) across the heat pump coil ***shall*** be measured ***using a TrueFlow plate per Climate Crafters protocol***. This, along with the temperature difference across the coils and outdoor ambient air temperature at the outdoor coil, ***shall be reported to Climate Crafters***.

Airflow to each room shall be tested and reported to Climate Crafters. Adjustments in room airflow shall be made, if necessary, according to the room by room calculations, using the balancing dampers.

7.0 FILTERS

Air filters shall be installed in the return air system in a location that will be easily accessible to the user for filter servicing and in a position where all return air and outside air will pass through the filters before crossing the indoor coil. Filter types and sizes shall meet the standard manufacturer's instructions and recommendations. Filters that are not an intregal part of the equipment and selected by the manufacturer shall not exceed 400 FPM face velocity. Electronic air cleaners shall be accepted if the total CFM is within the range as specified by the manufactuer. Any filter that exceeds 0.22 inches pressure drop as installed shall not be allowed. Filter types and sizes shall meet the standard manufacturer's instructions and recommendations. No more than 400 feet per minute (FPM) face velocity shall be allowed. Filters should not be installed in crawl spaces.

8.0 NOISE AND VIBRATION ABATEMENT

8.1 Indoor Unit

Permanent means shall be provided to prevent transmission of objectionable noise or vibration generated by the indoor unit in accordance with the manufacturer's instructions and recommendations. Supply and return shall be sound lined a minimum of 4 feet from the air handler, with the exception of manufactured homes.

8.2 Outdoor Unit

Outdoor units shall be located to avoid transmission of objectionable noise to adjacent properties, sleeping areas, or other areas where noise control is critical. Where outdoor units are found to be in violation of state and local noise control ordinances, the Participating Installer shall be responsible for any modifications necessary to reduce noise. Unit base shall not be connected to the foundation.

9.0 REFRIGERANT PIPING

9.1 Materials

Field-supplied refrigerant piping shall be clean, dehydrated, and sealed Types K and L seamless copper tubing or the manufacturer's pre-charged tubing. Fittings shall be wrought copper. Field supplied tubing shall be evacuated to 500 microns and purged and pressure tested as per manufacturer's recommendation; soft solders shall not be permitted.

9.2 Sizing

To maintain oil return to the compressor and avoid inefficiency and capacity loss, refrigeration piping or refrigeration line set shall be sized and installed in accordance with the manufacturer's instructions and recommendations. Piping between the two sections of split units shall not exceed the manufacturer's maximum recommended length, horizontally or

vertically, and shall be run parallel to building lines and in a straight and workmanlike manner to prevent oil traps.

9.3 Support

Refrigerant piping shall be properly supported in accordance with manufacturer's specifications, ARI, and UMC (Uniform mechanical Code).

9.4 Penetrations

Refrigerant piping passing through openings in the unit cabinet or the building structure shall be installed to prevent wear or sound generation due to contact with the cabinet or building structure. All penetrations shall be properly sealed.

9.5 Insulation

Suction lines shall be insulated with a minimum of 1/2" thick continuous closed-cell foam rubber. Where insulation is exposed to the elements, it should have a weatherproof covering. Vapor and liquid lines shall be separated so that heat exchange does not take place. Factory insulated pre-charged lines will be accepted.

9.6 Exposed Piping

All refrigerant piping exposed to possible damage from foot traffic around or near an outdoor unit shall be protected or buried in PVC or other corrosion-resistant pipe, in accordance with the manufacturer's instructions, to prevent damage to piping or pipe insulation or injury to people, and to permit replacement if necessary.

9.7 Leak Testing, Evacuation, and Charging

Factory, as well as field joints, shall be checked and any leaks found shall be repaired. Evacuation and charging shall be done in accordance with the manufacturer's instructions and recommendations and the latest edition of ARI Standard 260-75, 3.5-3.7.

10.0 CONDENSATE PIPING

10.1 Manufacturer's Recommendations

Condensate drain piping shall meet UMC and should be copper, plastic, or other corrosion-resistant material.

10.2 Drains

Condensate drain lines shall be trapped and run to an open drain or outside of the building foundation. Under no circumstances may condensate be drained into a crawl space or direct connected into a sewer line. When indoor units are located in attics, the installation shall include a secondary drain pain to collect condensate when a problem exists in the primary drain line. The secondary drain pan shall be connected to a drain line that will drip at a location that will draw attention to the problem in the primary drain line.

10.3 Condensate Pump

Condensate drain lines shall be pitched in the direction of flow to prevent backup of overflow of water in the drain pan. If the indoor unit is lower than the floor drain or dry well, a condensate pump shall be installed to pump condensate to the level of the drain or dry well. An automatic control to shut down system in case of pump failure shall be installed. A check valve shall be installed if pump is not equipped with one.

11.0 ELECTRICAL

11.1 Field Wiring

All field wiring, line and low-voltage, shall comply with the manufacturer's recommendations, the National Electrical Code, and all local codes and ordinances.

12.0 INDOOR THERMOSTATS

12.1 Installation

Indoor thermostats should be located and installed according to the manufacturer's instructions and recommendations. Thermostats generally are installed 5 feet off the floor on an inside wall in the return airflow pattern, and where they are not in the sun or any other heat source at any time.

12.2 Thermostat Staging

The first stage of resistance electric heat (“auxiliary stage”) shall be controlled by the second stage of the indoor thermostat. Thermostat indicator lights ***shall*** provide a visible indication when the auxiliary stage or emergency heat are operating.

12.3 Heating and Cooling

Thermostats used for both heating and cooling shall have a manual changeover feature or heating/cooling lockout to prevent cross-cycling between heating and cooling.

12.4 Emergency Heat Relay

All indoor thermostats shall include a manual selector switch to permit all supplemental heaters or the furnace to be energized under control of the indoor thermostat (with the compressor and outdoor thermostats bypassed) when the compressor or refrigerant system is inoperative.

13.0 ADD-ON HEAT PUMP TO GAS, PROPANE OR OIL FURNACE

13.1 Indoor Coil

For an add-on heat pump, the indoor coil shall be installed in the downstream air from the heat exchanger according to the Uniform Mechanical Code. (UMC).

13.2 Furnace Operation

The furnace shall lock out the heat pump when it operates on second-stage heat, unless heat pump manufacturer's special add-on heat pump control permits operation of both.

13.3 Emergency Heat Operation

Emergency heat switch shall activate the furnace and bypass the heat pump.

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Conservation and Renewables Discount Program
Specification Changes for FY2005

Ground Source Heat Pump - Appendix I

Section	Summary	New Spec	Old Spec
No changes were made to these specifications			

Appendix I

Geothermal Heat Pump Design and Installation Standards

October 1, 2001

1.0 CLOSED LOOP GROUND HEAT EXCHANGERS

1.1 Installation Personnel and Training Required.

1.1.1 The loop contractor must have a certified installer (technician) trained by IGSHPA or an IGSHPA certified manufacturer's training program.

1.1.2 Ground heat exchanger fabricators must have completed a heat fusion school in which each participant has performed a heat fusion procedure under direct supervision of an IGSHPA Association Certified Heat Fusion Technician or DOT certified heat fusion technician.

1.1.3 Certified technicians must attend a retraining school annually. A single failure of a fusion joint will void the certification, and the technician must be retested to demonstrate satisfactory performance.

1.1.4 Local and State laws and ordinances as they pertain to buried pipe systems shall be strictly followed or a variance obtained.

1.2. Design Methods and Compliance

1.2.1 The manufacturer of GSHPA equipment must provide design standards f or minimum ground heat exchanger lengths.

1.2.2 The manufacturer's design procedure must follow a recognized methodology such as presented in:

1.2.2.1 Closed-Loop/Ground-Source Heat Pump Systems: Installation Guide, GSHPA Publication, Oklahoma State University.

1.2.2.2 Data Design Manual for Closed-Loop/Ground-Source Heat Pump Systems, ASHRAE.

1.2.3 The ground heat exchanger design must be clearly documentable as complying with manufacturer's standards.

1.3. Ground Heat Exchanger Materials

1.3.1 Acceptable pipe materials for the underground buried portion of the ground heat exchanger are polyethylene and polybutylene.

1.3.2 The pipe and fittings of the buried system shall be warranted by the manufacturer for ground source heat pump service.

1.3.3 Sufficient information must be permanently marked on the length of the pipe that allows the pipe to be properly identified.

1.3.4 Specification of Polyethylene pipe will be by cell classification number. The specification for PE pipe shall be as follows:

"Polyethylene pipe furnished under this specification shall be manufactured in accordance with dimensional specifications of ASTM D-2513 or ASTM F-714, as appropriate, using a resin having a cell classification of ######Z as defined by ASTM D-3350. This resin shall exhibit not more than 20% failures (F20%) when tested for 192 or more hours under ASTM D-1693, Condition C. Acceptable products are ABC pipe as manufactured by ABC Pipe Company, Somewhere, USA or equal.

1.3.5 The minimum cell classification number acceptable for polyethylene pipe is PE3455434C or PE355434C when tested under ASTM D-3350.

1.3.6 The specification for PB pipe shall be as follows:

Polybutylene pipe furnished under this specification shall be manufactured in accordance with ASTM Standard ASTM D-2581. The material shall be:

1.3.6.1 Either Class B (general purpose and dielectric, in colors) or Class C (weather resistant, black in color containing not less than 2% carbon black).

1.3.6.2. Type II (density, 0.91 to 0.92 g/cm).

1.3.6.3 Grade 1. (Low rate 0.25 to 0.75 g/10 min).

For fusible pipe, dimensional standards are given by ASTM D 2666 and D3000.

1.4 Pipe Joining methods

1.4.1 The only acceptable method for joining buried pipe systems is by a heat fusion process. No other method is acceptable.

1.4.2 For polyethylene pipe, butt fusion is recommended.

1.4.3 For polybutylene pipe, socket fusion is recommended.

1.5 Flushing, Purging, Pressure and Flow Testing

1.5.1 Vertical loops will be pressure tested before installation.

1.5.2 All horizontal components of the ground heat exchanger will be flushed, pressure and flow tested prior to backfilling.

1.5.3 Heat exchangers will be tested hydrostatically at 150% of the pipe design rating or 300% of the system operating pressure if this value is the smaller of the two.

1.5.4 No visible leaks shall occur within a 30 minute period.

1.5.5 All fusion joints and loop lengths shall be visibly checked to verify that no leaks have occurred due to fusion joining or shipping damage.

1.5.6 Flow rates will be compared to calculated values to assure that there is no blockage or kinking of any pipe.

1.5.7 A minimum velocity of 2 ft/sec in each piping section must be maintained for a minimum of 15 minutes to remove all air.

2.0 PIPE PLACEMENT AND BACKFILLING

2.1. Horizontal Systems

2.1.1 Sharp bending of pipe around trench corners must be prevented by using a shovel to round corners. Manufacturer's recommendations must be followed.

2.1.2 Backfilling procedure will include prevention of any sharp-edged rocks from coming into contact with the pipe by removal of the rocks before backfilling, backfilling through a coarse screen for a 6 inch cover, or use a 6 inch cover of sand. Clods resulting from use of a backhoe must be broken up so air pockets formed around the pipe will not reduce heat conduction between the earth and the pipe. In some types of soils, wetting or flooding may be required.

2.1.3 Horizontal return bends must be backfilled by hand to properly support the pipes and prevent kinking.

2.2 Vertical Bore Holes.

2.2.1 The dry section of a certical bore holes must be backfilled to ensure good heat transfer. Local and State codes as to backfilling requirements must be followed. In some cases a bentonite grout/slurry will be required.

3.0 INDOOR PIPING AND CIRCULATION SYSTEM

3.1 Circulator Sizing and System and Components

3.1.1 The circulator wattage should not exceed 100 watts/ton. For circulation systems with water control value does not apply. The use of water control valves on closed loops is not recommended unless required by the manufacturer.

3.1.2 Proper sizing of the circulating pump will be within the Heat Pump Manufacturer's recommended flow rate for the specified unit.

3.1.3 Particulate contaminants must be removed if they exist or could become a problem for the circulation pump.

3.1.4 Pressurization of the circuit to a minimum of 10 to 15 psi when installed in the summer and 25 to 30 psi when installed in the winter.

3.1.5 The circulation system must incorporate flow and temperature sensing for testing the performance of the water side of the heat pump system. Pressure and temperature sensing ports at the inlet and outlet of the heat pump water heat exchanger are acceptable. The sensing ports should be within two (2) feet of the heat pump.

3.1.6 Service valve handles should be removed and the port plugged.

3.1.7 Boiler type service valves are not recommended.

3.1.8 Garden type hose connections must not be left on the circulation system.

3.1.9 Transition fitting must be inside or accessible.

3.1.10 All indoor piping must be insulated.

3.2. Antifreeze Selection and Use.

3.2.1 Manufacturer's recommended/required antifreeze solutions must be stated and meet Local and State requirements data.

3.2.2 Acceptable circulation component material for the antifreeze specified must be given.

3.2.3 Manufacturer will provide a list of all known acceptable materials used in the closed-loop circulation system. All metal parts contacting the circulating fluid must be defined in terms of metallurgical content.

3.2.4 Manufacturer's recommendations should be followed when charging an earth loop with antifreeze. The antifreeze solution must be acceptable under state and local codes. The solution type must be clearly tagged on each system.

3.2.5 In cases where the antifreeze is considered flammable, the antifreeze must be diluted with water to a point that it is nonflammable before it can be taken indoors.

3.2.6 All systems must be labeled and identified at the service ports. The labels must be of a permanent type with the following information:

3.2.6.1 Antifreeze type and concentration
3.2.6.2 Service-date.
3.2.6.3 Company name.
3.2.6.4 Company phone number and responsible party or person.

4.0 GROUND SOURCE HEAT PUMPS

4.1 Water Source Heat Pumps.

4.1.1 Water source heat pumps used in conjunction with ground heat exchangers must be certified by the respective manufacturer to operate satisfactorily at the recommended maximum and minimum entering water temperatures as set forth in the design of the ground heat exchanger.

4.1.2 The maximum and minimum design entering water temperatures shall not exceed the manufacturer's published data.

4.1.3 The water source heat pump will be ARI certified under rating ARI 325 for ground water heat pumps. For ground heat exchanger designed with EWT in the heating mode of 60 degrees Fahrenheit or greater, ARI 320 is acceptable.

4.1.4 Maximum and minimum entering liquid temperatures will be determined by the local ground temperatures and acceptable practice and within the manufacturer's limits.

4.2 Heat Pump Piping and materials.

4.2.1 All indoor piping, including the heat pump water heat exchanger must be insulated to prevent condensation.

5.0 AIR FLOW REQUIREMENTS

5.1 Heat Pump Air Flow.

5.1.1 The heat pump air flow must be within the manufacturer's guidelines.

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Conservation and Renewables Discount Program Specification Changes for FY2005

Long Term Super Good Cents Technical Specifications

Section	Summary	New Spec	Old Spec
pages 43, 48, 55	Single, Multifamily Definition	Multifamily = 5 units or more Single Family = 4 units or less	Multifamily = 6 units or more Single Family = 5 units or less

LONG TERM SUPER GOOD CENTS
PART I
TECHNICAL SPECIFICATIONS
FOR SITE-BUILT SINGLE AND MULTIFAMILY HOMES
October 1, 2004
TABLE OF CONTENTS

Index to Sections

CHAPTER 1: DESIGN QUALIFICATION AND CERTIFICATION

1.1 **General**: Electrically heated residences meeting the Long-Term Super Good Cents® (LTSGC) requirements meet or exceed the energy efficiency levels specified by the Northwest Power Planning Council in the Model Conservation Standards (MCS) amendment for New Residential and Commercial Construction, published April 1991. These requirements are listed in section 1.2.

Both the Northwest Conservation and Electric Power Plan and the MCS amendment are available from the Northwest Power Planning Council, 851 SW. 6th, Suite 1100, Portland, Oregon 97204, Telephone (503) 222-5161:

1.2 **MCS Reference Path for Electrically Heated Residences:**

COMPONENT		Zone 1 (<6000 HDD)	Zone 2 (6-7500 HDD)	Zone 3 (>7500 HDD)
Ceilings 1/	Attic	R-49 Adv.	R-49 Adv.	R-49 Adv.
	Vaults	R-38	R-38	R-38
Walls 1/	Above Grade	R-26 Adv.	R-26 Adv.	R-26 Adv.
	Below Grade Interior with R-5 thermal break 4/	R-21	R-21	R-21
Floors	Over Crawlspaces and Unheated Basements	R-30	R-30	R-38
	Slab-on-Grade Perimeter	R-15	R-15	R-15
Glazing 3/	Maximum tested U-value Reference Area (% of Floor)	U-0.35	U-0.35	U-0.35
	Single Family	15%	15%	15%
	Multifamily	12%	12%	12%
Exterior Doors		U-0.19	U-0.19	U-0.19
Assumed Infiltration Rate 2/ (ACH)		0.35	0.35	0.35
Duct Insulation	Rigid	R-11	R-11	R-11
	Flexible	R-8	R-8	R-8
Water Heaters		***See Section 2.7, Table B***		
Mechanical ventilation and pollutant source control in all Climate Zones.				

1/ Adv. indicates advanced framing techniques. Use standard wall framing and advanced attics for Multifamily structures (5 or more units). Duplexes qualify as Single Family structures.

2/ The assumed infiltration rate (ACH) is for heat-loss calculations only.

3/ Unlimited glazing is acceptable IF all components meet the requirements of this table. Area weighted U-factors for individual components which meet the component requirements of this table are acceptable.

4/ A thermal break having a minimum value of R-5 is required between slab floors and all walls and footings.

Table A - REFERENCE U-FACTORS

Component	Maximum Heat Loss Rate	
Attics	0.020	
Vaults	0.027	
Above-grade Walls	0.041 for single family	0.044 for multifamily
Below-grade Walls (Depth below grade)	U-value	F-value
2 ft.	0.042	0.592
3.5 ft	0.040	0.556
7 ft	0.035	0.503
Floors over unheated spaces	Heating Zones 1 & 2	Heating Zone 3
(U-value)	0.029	0.025
Slab-on-grade (F-value)		0.52

The reference U-factors are both single family and multifamily except as noted.

Advanced-frame walls have studs on 24-inch centers with a double top plate and a single bottom plate. The corners use 2 studs or other means of fully insulating the corners, and 1 stud is used to support each header. The headers have double 2X material with R-10 insulation. The exterior wall cavity is fully insulated at intersections with partition walls. Standard and intermediate wall framing are described in ***Part II of these specifications "Long-Term Super Good Cents Program Default Heat Loss Coefficients for Site Built Single Family and Multifamily Homes."***

An advanced-frame attic is any combination of heel height, insulation material and baffles that provides the required ventilation space and a minimum of R-38 at the interior edge of exterior walls. The insulation shall increase to the full R-value at the highest rate allowed by the roof pitch and taper down to reach the outside edge of the exterior wall or to blocking between rafters.

1.3 Existing Codes and Regulations: These specifications are intended to meet or exceed applicable existing building codes and Federal regulations. In any case where a Federal, State or local code or regulation exceeds these requirements, that code or regulation applies.

1.4 Qualification: To qualify in the Long-Term Super Good Cents Program, a building design must be reviewed and qualified by a representative of a Super Good Cents utility. Unless otherwise stated, "approved" means approved by the Super Good Cents utility.

The building shall meet the MCS energy performance requirements established by the Northwest Power Planning Council (see section 1.2) through one of the following three approaches:

1. Thermal Performance Standards calculated with WATTSUN, Sunday, or other approved methods using the heat-loss coefficients in ***Part II of these specifications "Long-Term Super Good Cents Program Default Heat Loss Coefficients for Site Built Single Family and Multifamily Homes,"*** Except NFRC certified fenestration products which shall use the NFRC labeled U-factor;

2. Energy Budgets calculated with WATTSUN, Sunday, or other approved methods using the heat-loss coefficients in ***Part II of these specifications "Long-Term Super Good Cents Program Default Heat Loss Coefficients for Site Built Single Family and Multifamily Homes,"*** Except NFRC certified fenestration products which shall use the NFRC labeled U-factor; and

3. Prescriptive paths using section 1.2 OR developed by the customer using the prototype houses and instructions in Appendix A of this reference.

1.5 Solar Access: If passive solar design is used to qualify the house, the effective solar glazing shall be 8 percent or more of floor area, there shall be increased thermal mass, common living areas shall be on south side, and solar gains shall be based upon actual sun and shading conditions at the site. Solar designs shall be accompanied by a sun chart, or approved equal, to document actual size conditions for current solar access.

A plot plan shall document future solar access by indicating on the site plan that the solar aperture will not be shaded by a hypothetical 6-foot fence at the southern property line or by a hypothetical "pole" representing average building heights of houses, located at the center of the buildable area of adjacent lots to the south.

Solar glazing shall receive a minimum of 80 percent direct solar exposure between 9 a.m. and 3 p.m. during the heating season.

1.6 Certification: To be certified, the building shall be verified by the Super Good Cents customer to comply with the requirements in this document.

1.7 Additional Utility Requirements: Super Good Cents utilities may add requirements more stringent than those in this specification.

CHAPTER 2: THERMAL EFFICIENCY

2.1 Insulation Coverage: All insulation materials shall be installed according to the manufacturer's instructions to achieve proper densities, avoid compression and voids, and maintain uniform R-values. To the maximum extent possible, insulation shall extend over the full component area to the intended R-value.

2.1.1 General: All insulating materials shall comply with sections 1713 and 1714 of the 1991 Uniform Building Code (UBC) and be installed to meet all applicable fire codes.

2.1.2 Chimneys: Insulation installed around chimneys shall comply with Chapter 37 of the Uniform Building Code (UBC).

2.1.3 Vents and Baffles: Ventilation baffles in attics shall be permanent, weather-resistant retainers and allow insulation to be installed to the outer edge of the exterior wall to the fullest depth possible. All vents for attic/roofs and crawlspaces shall be clear of insulation.

2.1.4 Recessed Fixtures: Recessed fixtures (e.g., medicine cabinets, electrical panels, recessed lights, heating equipment, etc.) shall be covered by the full depth of insulation required by the component assembly. (See section 2.5 for air sealing requirements.)

EXCEPTION: One percent of the component area (e.g., vaulted ceiling, wall) may have a minimum of R-10 insulation between the fixture and the building exterior IF required ventilation clearances are maintained.

2.1.5 Hatches: Hatches connecting conditioned spaces to attics and crawlspaces shall be insulated to at least the requirement for the appropriate component and climate zone except R-38 is allowed for ceiling hatches.

2.1.6 Below-Grade Walls: Below-grade wall insulation shall extend from the top of the wall to the floor on the interior, or to the top of the footing on the exterior.

2.1.7 Rim Joists: All rim joists in heated basements or crawlspaces, or between floors, shall be insulated to the above-grade wall R-value.

2.1.8 Slabs: On-grade slab floor insulation shall be installed along the entire perimeter, and shall extend downwards from the top of the slab a minimum of 24 inches. A combination of vertical and horizontal insulation totaling 24 inches is acceptable.

Slabs in heated spaces shall have an R-5 thermal break between footings and slabs in adjacent unconditioned spaces.

Below-grade slabs shall have an R-5 thermal break between below-grade walls and footings.

Radiant slabs (those heated by hydronic piping or other active slab heating methods) shall have R-15 perimeter insulation and a minimum of R-10 under the remainder of the slab, beneath the heating system.

2.1.9 Hydronic-Heating Pipe Insulation: All exposed pipes in unheated areas used for hydronic heating shall be insulated to a minimum of R-4 using preformed insulation.

2.2 Doors and Glazing: Doors and glazing shall meet the following requirements.

2.2.1 Thermal Ratings: Windows, skylights and sliding glass doors shall be NFRC certified and labeled.

Exterior doors that have not been tested shall use the default U-factors in ***Long-Term Super Good Cents Program Default Heat Loss Coefficients for Site Built Single Family and Multifamily Homes***, Table 6-1. Entry doors with glazing shall use door default U-factors in ***Long-Term Super Good Cents Program Default Heat Loss Coefficients for Site Built Single Family and Multifamily Homes***, Table 6.2.

2.2.2 Infiltration Ratings: Manufactured doors shall be tested for air infiltration using the ANSI/ASTM E-283-84 "Standard Test Method for Rating of Air-Leakage through Exterior Windows, Curtain Walls, and Doors." The tests shall be conducted at a differential pressure of 1.57 lbf/ft^2 (equivalent to 25 mph wind speed). Doors shall not exceed 0.2 CFM/linear foot of perimeter for swinging doors or 0.25 CFM/ft^2 of door area for sliding doors.

2.2.3 Site-Built Glazing: Where allowed by the utility, site-built, wooden-sash windows shall have a an emissivity coating of 0.2 or less and fit tightly. Fixed lites shall be retained by stops, and sealed. The window frame-to-framing joint shall be sealed. Double-glazed units shall be argon filled and have a minimum space of 1/2-inch between lites. Triple-glazed units shall be argon filled and have a minimum spacing of 1/4-inch between lites.

2.2.4 Site-Built Doors: Where allowed by the utility, site-built doors are exempt from thermal conduction and air infiltration testing, but shall fit tightly. The door frame-to-framing joint shall be sealed.

2.2.5 Weatherstripping: All operable joints in windows and doors shall be weather-stripped.

2.3 Air-Leakage Control: All Long-Term SGC buildings shall use either standard or advanced air-leakage control in section 2.3.1 or 2.3.2 for qualification:

2.3.1 Standard: Each building shall have a tested air-leakage of 7.0 air-changes per hour or less at 50 Pascals, using the procedures in Appendix B of this reference OR comply with the following prescriptive requirements:

All penetrations through the building envelope, including the following, shall be sealed (e.g., caulking, expanding foam, house wrap permeable to water vapor, tape, backer rod, gasket material, etc.) to limit air-leakage.

1. around glazing and door frames, between the unit and the interior sheet rock or the rough framing;

2. over all framing joints where floors intersect exterior walls (e.g., at rim and band joists);

3. at the top and bottom of the mudsill on homes with basements or heated crawlspaces;

4. around openings in the building envelope for access hatches, ducts, plumbing, electricity, telephone, cable television lines in walls, ceilings and floors, and through-the-wall vents;

5. at openings in the ceiling, (e.g., where ceiling panels meet interior and exterior walls, at exposed beams, masonry fireplaces, woodstove flues, etc.); and

6. around all outlet, switch, or other electrical boxes in the exterior walls, ceilings, or floors.

In addition to the above, multifamily buildings (5 or more units) shall also be sealed at all penetrations into joist spaces between floors.

2.3.2 Advanced: Buildings shall have tested air for leakage according to the procedures in Appendix B of this reference and shall have 1.8 air-changes per hour at 50 Pascals.

2.4 Backdraft Dampers: Intermittently-operated fans, or other non-heat-recovery systems, exhausting air from the building shall be ducted to the outside and have a backdraft or automatic damper in the exhaust duct.

2.5 Recessed Fixtures: Recessed fixtures (e.g., wall heaters, fans, medicine cabinets, electrical panels, etc.) shall be sealed to the component assembly to restrict air-leakage.

Recessed light fixtures shall meet ONE of the following requirements:

1. they must be IC-rated, double-can units sealed around the exterior to be air tight,

2. IC-rated units or fluorescent fixtures installed in a sealed "box" that extends the ceiling above the light fixture, or

3. type IC-rated units, certified under ASTM E-283 to have no more than 2.0 cfm air movement from the conditioned space to the ceiling cavity. The lighting fixture shall be tested without the trim at 75 Pascals or 1.57 lbs/ft^2 pressure difference, and have an attached label showing compliance.

The mounting flange on the exterior of the can, or the sealed "box," must be caulked to the ceiling finish/air barrier.

2.6 Wood stoves, Fireplaces and Other Combustion Appliances: Vented combustion appliances inside the heated space shall meet the requirements of sections 2.6.1 through 2.6.3 below. Unvented combustion appliances are NOT acceptable.

2.6.1 Woodstoves and Fireplaces: Masonry and factory-built fireplaces and woodstoves shall be installed with the following features:

1. Doors: Closeable metal or glass doors covering the entire opening of the firebox.

2. Combustion Air: Combustion-air intakes supplying primary combustion air to the appliance shall be sized as follows:

a. for factory-built wood-burning stoves, inserts, or fireplaces as specified by the manufacturer, but not less than 4 inches in diameter and not more than 20-feet in length.

b. for site-built appliances (e.g., masonry fireplaces, etc.), at least 4 inches in diameter and not more than 20-feet in length.

3. Fireplace Flue Dampers: For solid-fuel burning fireplaces only, a tight-fitting flue damper with a readily accessible control.

2.6.2 Other Combustion Appliances: All other combustion appliances inside the heated space shall be provided with outside primary combustion-air ducted directly to the appliance.

EXCEPTION: Gas cooking appliances without outside combustion-air shall have an exhaust fan directly serving those appliances that exhausts air to the outside.

EXCEPTION: Gas clothes dryers.

2.6.3 Combustion Exhaust: All combustion exhausts shall be separated by a minimum of 3-feet vertically or 10-feet horizontally.

2.7 Electric Water Heaters: Water heaters shall have GAMA certified minimum EF (Energy Factor) not less than specified in the Table B for the appropriate tank storage volume.

Table B - Electric Water Heater Efficiency Standards

Tank Size (gallons)*	Energy Factor
30	0.96
40	0.94
50	0.93
65	0.91
80	0.89
120	0.84
*The rated storage volume, which equals the storage capacity of the water heater, in gallons, as specified by the manufacturer.	

Water heaters on concrete basement or slab-on-grade floors shall be placed on a noncompressible insulating pad of R-10 or greater if full underslab insulation is not present. R-10 insulation shall also be placed under water heaters on raised platforms in unheated spaces.

Gas water heaters are exempt from the efficiency and insulating pad requirements.

CHAPTER 3: HEATING SYSTEMS

3.1 General: The primary heating system in Long-Term Super Good Cents homes shall be electric. The heating contractor is responsible for designing and installing the heating system to meet all UMC, NEC, applicable local codes and equipment manufacturer's requirements.

3.2 Control Requirements: Each separate heating system shall have at least one thermostat per zone mounted on an interior wall, at the manufacturer's recommended height, to regulate temperature. Each thermostat shall have numerical degree settings.

3.2.1 Central Systems (Non-Heat Pump): For central furnace or similar type systems, a low-voltage, heat-anticipating or microprocess-controlled electronic thermostat shall be installed.

3.2.2 Zonal Systems: There shall be one heat-anticipating, bi-metal thermostat OR a microprocessor-controlled electronic thermostat per zone.

3.2.3 Heat Pumps:

3.2.3.1 Installation

Indoor thermostats should be located and installed according to the manufacturer's instructions and recommendations. Thermostats generally are installed 5 feet off the floor on an inside wall in the return airflow pattern, and where they are not in the sun or any other heat source at any time.

3.2.3.2 Heating and Cooling

Thermostats used for both heating and cooling shall have a manual changeover feature or heating/cooling lockout to prevent cross-cycling between heating and cooling.

3.2.3.3 Automatic Setback (optional)

Indoor thermostats may have the capability of automatically reducing heating thermostats set point during unoccupied hours, and lockout strip heat during warmup by outdoor thermostats or an electronic programmed thermostat which shall control the strip heat on warm up.

3.2.3.4 Energy Heat Relay

All indoor thermostats shall include a manual selector switch to permit all supplemental heaters or the furnace to be energized under control of the indoor thermostat (with the compressor and outdoor thermostats bypassed) when the compressor or refrigerant system is inoperative. An indicator light, which is energized whenever the system is operating on emergency heat, shall be provided.

3.2.3.5 Microprocessor Thermostats

The first stage of electric heat shall be controlled by the second stage of the indoor thermostat. Thermostats should indicate auxiliary stage and emergency heat.

3.3 HVAC Ducts: HVAC ducts shall meet the following requirements:

3.3.1 Design Requirements

All duct work should be designed and installed in accordance with recommended practice as outlined in Air Conditioning Contractors of America (ACCA) Manual G, "Selection of Distribution Systems"; Manual E, "Room Air Distribution Consideration" and Manual D, "Residential Duct Design and Equipment Selection" or Sheet Metal and Air Conditioning Contractors National Association (SMACNA) "HVAC Duct System Design" or American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) handbooks. Duct sizing calculations and conclusions should be thoroughly documented and provided to the Customer and the Utility. Installation of balancing dampers is recommended.

3.3.1.1 Flex Duct

Flex duct shall not be used for main supply trunks in crawl spaces or areas that could be subject to physical damage from normal occupant activities, weather or animals. When flex duct is used for main trunks or run outs the size shall be determined by using the "Wire Helix Flexible Duct" scale on an ACCA Duct Sizing Slide Rule, or equivilent and all other requirements in Section 3.3 of these specifications shall be met.

3.3.1.2 Building Cavities As Ducts

Building cavities shall not be used as ducts to convey return or supply air.

3.3.1.3 Static Losses

Supply and return ducts shall be designed on the basis of not more than 0.10 and 0.08 inches loss per 100 feet respectively. Supply and Return Ducts shall be designed so that the total system static pressure does not exceed the available static pressure provided by the air handler at design CFM. Flex duct shall be supported in a manner that does not create restrictions in air flow and located to minimize bending.

3.3.1.4 Maximum Velocities

New duct work shall be designed so air velocities do not exceed the following:

Supply Ducts

Main Ducts	900 FPM
Branch Ducts	600 FPM
Supply Outlet Face Velocity	700 FPM
Return Grills Face Velocity	500 FPM
Filter Grille Face Velocity	300 FPM

Velocity shall not create unaceptable noise levels and return air shall be sufficient size to meet requirements of installed systems.

3.3.1.5 Diffusers and Registers

Proper diffusers and registers shall be selected and installed in the proper locations.

3.3.1.6 Branch Ducts

Branch out runs should be a minimum of 6 inches in diameter except to bathrooms.

3.3.1.7 Duct Connections

Ducts shall be properly supported before insulation is installed. All duct joints, plenum drives, metal joints to include all slips and drives shall be mechanically fastened with screws. Flexible ducts shall be attached using nylon/plastic straps tightened with a manufacturer approved tool (hand tightening is not acceptable) or stainless steel worm drive clamps. Mastic and/or tape shall not be used as mechanical fasteners.

3.3.2.1 Zonal Pressure Relief

Sufficient return pathways should be provided bewteen axial zones (e.g. bedrooms) and the main body of the dwelling to limit pressurization of these zones to 3 Pa or less when the system is operating at maximum system airflow. Return pathways include return ducts, pass-through grilles, pressure-relief ducts, or similar devices.

3.3.2 Duct Installation

3.3.2.1 Insulation

3.3.2.1.1 All new rigid metal ducts and plenums and accessible existing rigid metal ductwork outside the heated space shall be insulated to an installed value of at least R-8. A vapor barrier meeting a flame spread rating of 25 or less and smoke developed rating of 50 or less (in accordance with ASTM E-84-88) shall be installed on the outside surface of the insulation.

3.3.2.1.2 All new ducts and plenums that are internally lined with insulation outside the heated space shall be installed in accordance with SMACNA's Duct Liner Application Standard, second edition. The total R-value of this duct work shall be no less than R-8.

3.3.2.1.3 All flexible HVAC ducts outside the heated space shall have an Air Diffusion Council (ADC) certified minimum R-value of R-8.

3.3.2.1.4 All HVAC ducts routed within exterior wall cavities shall be insulated to a minimum of R-14 between the duct and the exterior wall sheathing.

3.3.2.1.5 All duct insulation shall be installed and supported using mechanical fasteners such as permanent plastic straps or nylon twine. Tape is not a mechanical fastener. Tape may be used at insulation seams to provide a continuous barrier.

3.3.2.2 Air Tightness

All HVAC supply and return ducts, air handlers, and plenums inside and outside the heated space shall be sealed at all joints and corners, including prefabricated joints, with duct mastic. UL181A-M or UL181B-M mastic shall be used on rigid metal ducts. UL 181B-M mastic shall be used on flex ducts. It is unnecessary to seal longitudinal seams unless they are damaged. Tape is not allowed except for use on operable doors in the system such as on the air handler. In this case, foil tape with a

15-mil butyl sealant shall be used; alternately, the joints can be cleaned with a suitable solvent and sealed with a UL-181 listed tape.

3.3.3 Additional Duct Requirements for Heat Pump Installations

3.3.3.1 Minimum Air Volume

The air distribution system design and installation shall be such that air flow across the indoor coil is as specified in the heat pump manufacturer's literature or at least 400 cfm per 12000 BTU ARI conditions if the manufacturer’s literature is not specific. Airflow should be between 425 and 450 cfm at start up.

3.3.3.2 Start-up Tests and Measurements

After installation and start-up, a total airflow in the heat pump mode across the heat pump coil shall be made and recorded at the air handler. This, along with the temperature difference across the coils and outdoor ambient air temperature at the outdoor coil, should be reported to the customer.

The CFM shall be measured with a flow plate, or by combining the temperature rise test with measurement of element voltage and amperage in emergency heat mode and making the needed calculations.

CHAPTER 4: MOISTURE AND AIR QUALITY

4.1 Moisture Vapor Transfer: The following shall be installed to limit moisture transfer:

4.1.1 General: A vapor retarder of not more than 1.0 perm shall be installed in, or applied to, exterior walls, ceilings, and floors. It shall be installed according to the manufacturer's specifications, on the warm side (in winter) of all insulation. The retarder shall be considered to be on the warm side if the R-value of the materials between it and the heated space is not more than 33 percent of the total R-value of the component section at the insulated cavity.

4.1.2 Slab Floors: Slab floors shall have a minimum of 4 inches of sub-slab gravel meeting ONE of the following requirements:

1. ASTM Standard C33, "Standard Specifications for Concrete Aggregates," or any successor standards, and shall be size Number 67 or larger size aggregate as listed in Table 2, Grading Requirements for Coarse Aggregates; or,

2. the 1988 Washington State Department of Transportation specifications 9-0.31(3), "Coarse Aggregate for Portland Cement Concrete," or any successor standards, and aggregate size shall be of Grade 5 or larger size aggregate as listed in 9-03.1(c), "Grading;" or,

3. is screened, washed, free of deleterious substances in a manner consistent with ASTM C33, with 100 percent of the gravel passing a 1-inch sieve and less than 2 percent passing a #4 sieve. Sieve characteristics shall conform to those acceptable under ASTM C33.

4.1.3 Crawlspace Ground Cover: In crawlspaces, a ground moisture barrier of 6-mil black polyethylene, or equal approved by the utility, shall be installed covering the entire ground surface of the crawlspace.

4.2 Attic and Crawlspace Ventilation: Outdoor air ventilation shall be provided in the following places, at the following rates:

4.2.1 Attics/Ceilings: Adequate cross ventilation shall be maintained above all ceiling insulation by providing both low and high vents. At least 1 ft^2 of net-free vent area shall be provided for every 300 ft^2 of ceiling area with 50-to-60 percent of the vent area located near the roof ridge and 40-to-50 percent located near the eaves. One-level venting may be used if at least 1 ft^2 of net-free vent area is provided for every 150 ft^2 of ceiling area and adequate cross ventilation can be maintained.

4.2.2 Crawlspaces: Crawlspaces shall be ventilated by openings in at least two opposing exterior foundation walls with a net-free vent area of not less than 1 ft^2 for each 150 ft^2 of underfloor area. Where local code allows, this ventilating area may be reduced to 1 ft^2 for every 300 ft^2 of underfloor area if the crawlspace soil is dry, well drained and a ground cover meeting the provisions of 4.1.3 has been installed.

Where allowed by code, mechanical ventilation of 2 ACH or higher is acceptable.

4.3 Mechanical Ventilation: Whole-house ventilation systems, which include exhaust-air fans and outside-air intakes, are required and shall be designed and controlled to provide adequate ventilation for the occupants while minimizing energy penalties.

Whole-house ventilation systems shall use remotely-mounted exhaust fans (i.e. more than 4-feet from the pick-up grille) or surface-mounted fans (i.e. exhaust fan motors within 4-feet of the pick-up grille). Surface-mounted fans shall have a sone rating of 1.5 or less for intermittently-operating systems and 1.0 or less for continuously-operating systems. Both remotely and surface-mounted fans shall installed to limit the transmission of fan vibrations to the building structure. Intermittently-operating whole-house ventilation fans shall be controlled by 24-hour timers, with a minimum of 2 on-periods per day, and shall be set to operate for a minimum of 8 hours per day.

Multifamily buildings (5 or more units) shall have one of the following ventilation systems for each unit:

1. a continuously-operating ventilation system providing a measured minimum airflow of 0.35 air-changes per hour (ACH) or 15 cfm for each bedroom and 15 cfm for the main living area with a maximum rate of 0.5 ACH, or meet the prescriptive requirements using the HVI certified fan flows in the following table.

TABLE C: Multifamily Continuous Ventilation

Number of Bedrooms	Minimum Certified Fan Flow at 0.25 in W.G.	Maximum Certified Fan Flow at 0.25 in W.G.
1	30 cfm	60 cfm
2	50 cfm	75 cfm
3	60 cfm	90 cfm
4	80 cfm	120 cfm

When the whole-house fan provides pickups in, or is located in, the bathroom or kitchen in lieu of spot ventilation fans, the whole-house fan shall exhaust 20 cfm from the bathroom and/or 25 cfm from the kitchen. A single, continuously-operating, integrated and whole-house fan, or fan pickup, in one bathroom is acceptable if spot ventilation fans are provided in the kitchen and in the other bathrooms.

2. an integrated HVAC ventilation system (option 4) described below for single family ventilation if it is provided by a separate HVAC system for each unit, or

3. an intermittently-operating system exhausting not less than 1.5 times the minimum prescriptive flow rates in Table A above. Intermittent exhaust devices may replace one more spot ventilation devices IF all spot ventilation requirements are met.

Single-family buildings (4 or fewer units) shall provide whole-house ventilation systems which exhaust indoor air at the rates specified in section 4.3.1 for each unit. The four general system designs for single-family residences are:

1. Integrated Spot and Whole-House Design: This system uses one or more exhaust fans to provide spot and whole-house ventilation. The fan(s) is controlled by both a manual switch, crank timer, or dehumidistat in the bathroom for spot ventilation AND a 24-hour timer to provide whole-house ventilation.

2. Continuous Ventilation: This system uses a continuously-operating fan to exhaust air at a minimum rate of 25 cfm for the kitchen and 20 cfm per bathroom, with a maximum rate of 0.5 ACH.

   A fan exhausting air from the kitchen and from each bathroom also provides spot ventilation. An integrated spot and whole-house fan is acceptable if spot ventilation is also provided for the kitchen and for all bathrooms.

3. Discrete Spot and Whole-House Design: This system uses separate exhaust fans and control systems to provide spot and whole-house ventilation.

Spot Ventilation is provided by standard bath fans controlled by a manual switch, crank timer or dehumidistat, and a kitchen range hood.
Whole-house ventilation is provided by a fan, controlled by a 24-hour timer, that exhausts air from a central hallway near the bedrooms.

4. Forced-Air Heating/Cooling System Integrated Design: In this system, the forced-air heating/cooling system is used to bring outside air into the return-air plenum and distribute it through the supply ducts. Spot ventilation is provided by bathroom and kitchen exhaust fans

   A 24-hour timer, controls the heating/cooling system air handler, a motorized damper in the outside-air supply duct, and an exhaust fan to provide ventilation and to reduce building pressurization.

   An outside-air supply duct meeting the diameter and length requirements in section 4.3.7.2, is connected to the return-air plenum within 36 inches of the air handler. The outside-airflow is controlled by a balancing damper or constant airflow regulator in the outside-air supply duct to meet the airflow specified in section 4.3.1.

4.3.1 Exhaust Airflow Rates: Exhaust airflow rates shall meet either the following Performance or Prescriptive requirements.

Performance Path: The minimum combined measured airflow capacity for whole-house exhaust systems shall be 0.35 ACH, but not less than 15 cfm per bedroom and 15 cfm for the main living area. The maximum ventilation rate for non-heat recovery ventilation systems shall not exceed 0.5 ACH for houses of 1400 ft^2 or larger or 0.65 ACH for houses smaller than 1400 ft^2.

Prescriptive Path: Whole-house ventilation systems that do not meet the performance path shall meet the HVI certified fan flow requirements, minimum duct diameters, and maximum duct lengths listed in this section.

TABLE D: Single Family Intermittent Ventilation

Number of Bedrooms	Minimum Certified Fan Flow at 0.25 in W.G.	Maximum Certified Fan Flow at 0.25 in W.G.
2 or less	50 cfm	75 cfm
3	80 cfm	120 cfm
4	100 cfm	150 cfm
5	120 cfm	180 cfm

Fans shall be certified by HVI at 0.25 inches water gauge as determined by HVI 916 (July 1993)..

The following table gives the minimum duct diameter, maximum duct length and maximum number of elbows for smooth ducts or 90 degree bends in flexible ducts based upon fan size.

TABLE E: Exhaust-Fan Duct Length vs. Diameter

	FLEX DUCT		SMOOTH DUCT		
FAN TEST Max CFM @ .25 W.G.	Flex Duct Diameter	Maximum Length Feet	Smooth Duct Diameter	Maximum Length Feet	MAXIMUM # 90° Elbows*
50	4"	25	4"	70	3
50	5"	90	5"	100	3
50	6"	No limit	6"	No limit	3
80	4"	Not allowed	4"	20	3
80	5"	15	5"	100	3
80	6"	90	6"	No limit	3
100	5"	Not allowed	5"	50	3
100	6"	45	6"	No limit	3
125	6"	15	6"	No limit	3
125	7"	70	7"	No limit	3

***** Subtract 10-feet from the maximum duct length for each additional elbow

4.3.2 Exhaust-Duct Insulation: All exhaust ducts in unheated spaces shall be insulated to at least R-4.

4.3.3 Exhaust Duct Termination: Exhaust ducts shall terminate outside the residence in a fitting with an area not less than the area of the duct.

4.3.4 Spot Ventilation: Spot ventilation fans, ducted to the outside of the envelope and meet the minimum capacities listed in the following table. The fan shall be certified at 0.25 inches of water gauge as determined by HVI 916 (July 1993). Kitchen range hoods or down-draft range exhaust fans may be rated at 0.1 inches of water gauge.

TABLE F: Spot-Ventilation Fan Capacity

Location	Certified Fan Capacity
Each bathroom	50 cfm
Kitchen	100 cfm

Exception: Separate spot ventilation is not required for a continuously-operating system which exhausts 25 cfm from the kitchen and 20 cfm from each bathroom.

4.3.5 Backdraft Dampers: A tight-fitting backdraft damper, capable of closing when intermittently-operating fans are not in use, shall be provided in each exhaust duct.

4.3.6 Controls: Intermittently-operating, whole-house exhaust fans shall have both automatic and manual controls. Automatic controls shall include a time clock or cycle timers with a minimum of two on-periods per day and be set to provide at least 8 hours of mechanical ventilation per day.

A manual override switch accessible to, and controllable by, occupants allows occupants to run the fan continuously or disable it if desired.

Parallel Wiring: The spot and whole-house ventilation controls may be wired in parallel, allowing the same fan to perform both functions. A whole-house exhaust fan, for example, may be wired to both the manual spot-ventilation switch in the bathroom and to a time clock.

4.3.7 Outside-Air Supply: The outside-air may be supplied by following the requirements of section 4.3.7.1 OR section 4.3.7.2 below.

1. Fresh-Air Inlets: Individual outside-air inlets shall:

   - be located to avoid drafts,
   - have a controllable and secure opening,
   - be sleeved or otherwise designed to prevent compromising the thermal integrity of the wall or window into which it is placed, and
   - provide a total opening area of at least 4 in^2 of net-free area or be HVI certified to provide 10 cfm at 10 Pascals for each bedroom and for each 300 ft^2 of combined living area.

2. Central Outside-Air Duct: A central duct providing outside-air directly to the return plenum of a forced-air heating/cooling system which circulates fresh air to the required rooms (used with Forced Air Heating/Cooling System Integrated Design). This duct shall have a motorized damper and a flow-control device to provide a supply airflow equal to the exhaust airflow rates specified in section 4.3.1. Duct diameter and length shall meet the following requirements:

TABLE G: Option 4 Air-Inlet Duct Length vs. Diameter

Number Of Bedrooms	Minimum Smooth Duct Diameter	Minimum Flex Duct Diameter	Maximum Duct Length 1/	Maximum Number of Elbows 2/
2 or less	6"	7"	20 ft	3
3	7"	8"	20 ft	3
4 or more	8"	9"	20 ft	3

1/ For lengths over 20-feet, increase the duct diameter by 1-inch.
2/ For more than 3 elbows, increase the duct diameter by 1-inch.

4.3.8 Outside-Air Source: The outside-air shall come from outside the building envelope and shall not be taken from the following locations:

- within 10-feet of an exhaust vent or combustion appliance flue outlet unless the vent/outlet is at least 3-feet above the air inlet
- where it will pick up objectionable odors, fumes, or flammable vapors
- a hazardous or unsanitary location
- a room or space containing any fuel-burning appliance
- within 10-feet of a plumbing vent unless the vent is at least 3-feet above the air inlet
- attics, crawlspaces, or garages

Protection: The outside-air source shall have adequate protection from entry by rain, insects, leaves, and other objects.

Flow Control: The outside-air source shall limit excessive airflows under normal operation.

4.3.9 Outside-Air Distribution: Adequate outside-air distribution shall be provided by individual room inlets, separate duct systems, or a forced-air system.

Where outside-air supplies are separated from the exhaust points, undercut doors, door or wall grilles, transoms grilles, or other approved means shall be provided to allow air circulation between spaces.

4.4 Formaldehyde Reduction Measures: All structural panel components of the house such as softwood plywood, particle board, wafer board, and oriented strand board shall be identified as "EXPOSURE 1," "EXTERIOR," or "HUD-Approved."

APPENDIX A

PRESCRIPTIVE OPTIONS FOR SITE-BUILT, SINGLE FAMILY HOUSING

1. Scope: This Appendix describes how utilities can develop prescriptive paths for Single Family residences in their service areas. Each prescriptive path must equal or exceed the base case for the appropriate climate zone and be approved by Bonneville. Each trade-off item must be an approved SGC measure.

2. Procedure: Using WATTSUN, SUNDAY, or other approved software, calculate the Thermal Performance or Energy Budget for ALL THREE prototype houses in the following table. All three prototypes must equal or exceed the base case for each prescriptive path.

PROTOTYPE COMPONENT AREAS

Component	Rambler 1344 ft^2	Split Level 1848 ft^2	Daylight Basement 2356 ft^2
Crawlspace floor	1344	1288	468
On-grade slab			30 lin. ft.
Below-grade wall @ 3.5 ft. average			544
Below-grade slab @ 3.5 ft. average			124 lin. ft.
Above-grade wall	1136	1732	1489
Windows	200	276	353
Doors	40	40	40
Flat ceiling	1344	1288	1160
Vaulted Ceiling			270
Volume	10752	14784	19833

APPENDIX B

BLOWER DOOR TEST PROTOCOL

1. Scope: This Appendix describes the blower door test protocol for testing the air-leakage of a single family house and representative residences in multifamily structures to meet the requirements of sections 2.3 of the Specifications.

2. When to Test: Testing shall occur after everything is roughed-in/ installed that will penetrate the building envelope (e.g., plumbing, electrical, HVAC, ventilation, combustion appliances, etc.) and the air barrier has been installed.

   Do not test when the outside wind speed exceeds 15-20 miles per hour.

3. House/Residence Preparation: All single family houses and representatives residences in multifamily structures shall be checked before testing to assure that following preparation measures have been completed.

   3.1 Building envelope: All windows and doors shall be properly closed, including pass-through wood-box doors and pet doors. All interior doors shall be left open.

   3.2 Ventilation openings: All exhaust fan openings, vent openings, and intake-air vents with backdraft dampers (e.g., dryer vents and kitchen, bathroom, utility room, whole-house, range vents, etc.) shall NOT be sealed.

   Exterior vent openings without backdraft dampers (e.g., some continuous ventilation systems) shall be temporarily sealed for the test. Heat recovery ventilator supply openings shall be sealed. Heat recovery ventilator exhaust openings should have backdraft dampers and shall not be sealed.

   3.3 Forced-air heating systems: Supply and return registers shall NOT be sealed and the heating system shall be turned off. HVAC ducts shall be tested with the envelope. Dampers in the outside-air supply duct into the return plenum shall be closed.

   3.4 Combustion appliances: All flue dampers, fireplace doors, and wood burning stove doors shall be closed, but NOT sealed.

4. Equipment Set-up: The blower door equipment shall be set-up using the following procedure:

   a. Keep the gauges at room temperature if possible. Cold temperatures may affect gauge accuracy.

   b. Install the blower-door assembly and seal all cracks and holes.

   c. Set up the gauge assembly with the gauges plumb and level.

   d. Attach a hose to the indoor pressure tap. Place the free end of the hose indoors away from the fan airflow path at the approximate height of the fan centerline.

   e. Exercise the gauges by blowing and sucking on the hoses to drive the gauges over their entire range six to eight times. Install the fan orifice plate, plug or seal all holes, and adjust the gauges to zero..

   f. Start the fan and depressurize the house to check for anomalies in the building envelope.

5. Performing the Test: Perform the test using the following procedures:

   a. Depressurize the house to 55 Pascals and reduce the pressure to 50 Pascals (0.205 inches of water).

   b. Tap the gauge to reduce stored spring energy from the gauge needle and wait for the needle to stabilize before recording the readings.

   c. View the gauge from directly in front when taking a reading. Maintain a consistent line of sight to avoid parallel errors or distortions from the gauge cover.

   d. Increase the pressure again and then retest at 50 Pascals.

6. Multifamily Structures: In multifamily structures, one corner and one middle apartment on each floor shall be tested according to the above protocol as representative residences. The apartment weighted average of the ACH @ 50 Pascals for the tested apartments shall be calculated for compliance with section 2.3 of the specifications.

LONG-TERM SUPER GOOD CENTS PROGRAM
PART II
DEFAULT HEAT-LOSS CO-EFFICIENTS
FOR SITE-BUILT SINGLE AND MULTIFAMILY HOMES

TABLE OF CONTENTS

CHAPTER 1: GENERAL

1.1 Scope: This Reference includes tables of seasonal average heat-loss coefficients for specified nominal insulation levels in the Super Good Cents program.

It also includes default U-values for windows and doors (15 mph table), which may be used as substitutes for the tested U-values required for glazing in section 2.2 in the Technical Specifications.

The heat-loss coefficients may also be used for heating system sizing.

1.2 Description: These coefficients were developed primarily from data and procedures in the 1989 ASHRAE Handbook of Fundamentals. Additional procedures, developed by Ecotope Inc., are detailed in the Super Good Cents Heat-Loss Reference Manual.

Co-efficients not contained in this Reference may be computed using the procedures listed in these references if the assumptions in the following sections and the SGC Heat-Loss Reference Manual are used, along with data from the sources referenced above.

CHAPTER 2: BELOW GRADE WALLS and SLABS

2.1 General: Table 2.1 lists heat-loss coefficients for below-grade walls and floors.

Co-efficients for below-grade walls are given as U-values (BTU/°F-hr per square foot of wall area). Co-efficients for below-grade slabs are listed as F-values (BTU/°F-hr per lineal foot of slab perimeter). They are derived from simulations using models and procedures developed by Ecotope, Inc., which are described in more detail in Volume I of the Super Good Cents Heat-Loss Reference.

Below-grade wall U-values are only valid when used with the accompanying below-grade slab F-value, and vice versa.

2.2 Component Description: All below-grade walls are assumed to be 8-inch concrete. The wall is assumed to extend from the slab upward to the top of the mud sill for the distance specified in Table 2.1, with 6 inches of concrete wall extending above grade.

Interior insulation is assumed to be fiberglass batts placed in the cavity formed by 2x4 framing on 24-inch centers with 1/2-inch of gypsum board as the interior finish material. Exterior insulation is assumed to be applied directly to the exterior of the below-grade wall from the top of the wall to the footing. The exterior case does not assume any interior framing or sheetrock.

In all cases, the entire wall surface is assumed to be insulated to the indicated nominal level with the appropriate framing and insulation application. Co-efficients are listed for wall depths of 2, 3.5, and 7-feet below grade. Basements shallower than 2-feet should use on-grade slab coefficients.

Heat-loss calculations for wall areas above grade should use above-grade wall U-values, beginning at the mudsill.

2.3 Insulation Description: Co-efficients are listed for the following four configurations:

1. Uninsulated: No insulation or interior finish.

2. Interior insulation: Interior 2x4 insulated wall without a thermal break between concrete wall and slab.

3. Interior insulation w/thermal break: Interior 2x4 insulated wall with R-5 rigid board providing a thermal break between the concrete wall and the slab.

4. Exterior insulation: Insulation applied directly to the exterior surface of the concrete wall.

TABLE 2-1
DEFAULT WALL U-VALUES AND SLAB F-VALUES FOR BASEMENTS

	Below Grade Wall U-value	Below Grade Slab F-value
2-Foot Depth Below Grade		
Uninsulated	0.350	0.59
R-11 Interior	0.066	0.68
R-11 Interior w/tb	0.070	0.60
R-19 Interior	0.043	0.69
R-19 Interior w/tb	0.045	0.61
R-10 Exterior	0.070	0.60
3.5-Foot Depth Below Grade		
Uninsulated	0.278	0.53
R-11 Interior	0.062	0.63
R-11 Interior w/tb	0.064	0.57
R-19 Interior	0.041	0.64
R-19 Interior w/tb	0.042	0.57
R-10 Exterior	0.064	0.57
7-Foot Depth Below Grade		
Uninsulated	0.193	0.46
R-11 Interior	0.054	0.56
R-11 Interior w/tb	0.056	0.42
R-19 Interior	0.037	0.57
R-19 Interior w/tb	0.038	0.43
R-10 Exterior	0.056	0.42

CHAPTER 3: ON-GRADE SLAB FLOORS

3.1 General: Table 3.1 lists heat-loss coefficients for heated on-grade slab floors, in units of BTU/°F-hr per lineal foot of perimeter. They are derived from simulations using models and procedures developed by Ecotope, Inc., and described in more detail in Volume I of the Super Good Cents Heat Loss Reference.

3.2 Component Description: All on-grade slab floors are assumed to be 6-inch concrete poured directly onto the earth. The bottom of the slab is assumed to be at grade line. Monolithic and floating slabs are not differentiated.

Soil is assumed to have a conductivity of 0.75 BTU/Hr-°F-ft^2. Slabs 2-feet or more below grade should use basement coefficients.

3.3 Insulation Description: Co-efficients are provided for the following three configurations:

2-Foot (or 4-foot) vertical: Insulation is applied directly to the slab exterior, extending downward from the top of the slab to a depth of 2-feet (or 4-feet) below grade.

2-Foot (or 4-Foot) horizontal: Insulation is applied directly to the underside of the slab, and run horizontally from the perimeter inward for 2-feet or 4-feet. The slab edge is exposed in this configuration.

Note: A horizontal installation with a thermal break of at least R-5 at the slab edge should use the vertical-case F-values.

Fully insulated slab: Insulation extends from the top of the slab, along the entire perimeter, and completely covers the area under the slab.

TABLE 3-1

DEFAULT F-VALUES FOR ON-GRADE SLABS

Insulation Type	R-0	R-5	R-10	R-15
Uninsulated slab	0.73	--	--	--
2-ft Horizontal (No thermal break)	--	0.70	0.70	0.69
4-ft Horizontal (No thermal break)	--	0.67	0.64	0.63
2-ft Vertical (or Horiz. w/T.B.)	--	0.58	0.54	0.52
4-ft vertical (or Horiz. w/T.B.)	--	0.54	0.48	0.45
Fully insulated slab	--	--	0.36	--

CHAPTER 4: CRAWLSPACE FLOORS

4.1 General: Tables 4.1 through 4.3 list heat-loss coefficients for floors over crawlspaces in units of BTU/°F-hr per square foot of floor.

They are derived from procedures listed in the 1989 ASHRAE Handbook of Fundamentals assuming an average outdoor temperature of 45°F, an average indoor temperature of 65°F, and a crawlspace area of 1350 ft^2 and 150 ft of perimeter. The crawlspace is assumed to be 2.5-feet high, with 24 inches below grade and 6 inches above grade.

4.2 Crawlspace Description: Four crawlspace configurations are considered: vented, unvented, enclosed and heated plenum.

Vented crawlspaces: Assumed to have three air-changes per hour, with at least 1 ft^2 of net-free ventilation in the foundation for every 300 ft^2 of crawlspace floor area. The crawlspace is not actively heated.

Floors over unheated areas, such as garages, may only use those values which have R-0 perimeter insulation.

Unvented crawlspaces: Assumed to have 1.5 air changes per hour, with less than 1 ft^2 of net-free ventilation in the foundation for every 300 ft^2 of crawlspace floor area. The crawlspace is not actively heated. Floors over unheated basements may only use those values which have R-0 perimeter insulation.

Heated-plenum crawlspaces: Assumed to have 0.25 air-changes per hour, with no foundation vents. Heated supply air from central furnace is blown into a crawlspace and allowed to enter the living space unducted via holes cut into the floor.

Enclosed floors: Assumes no buffer space, and a covering of 1/2-inch of T1-11 on the exterior of the cavity exposed to the outside air.

4.3 Construction Description: Floors are assumed to be either joisted floors framed on 16-inch centers, or post and beam on 4 by 8 foot squares. Insulation is assumed to be installed under the subflooring between the joists or beams with no space between the insulation and the subfloor. Insulation is assumed to be uncompressed.

Perimeter insulation is assumed to extend from the the top of the rim joist to the crawlspace floor and then inward along the ground (on top of the ground cover) for at least 24 inches.

Floor coverings are assumed to be light carpet with rubber pad.

TABLE 4-1

DEFAULT U-VALUES FOR FLOORS OVER VENTED CRAWLSPACE

Nominal R-value		U-value	
Floor	**Perimeter**	**Post & Beam**	**Joists**
0	0	0.112	0.134
	11	0.100	0.116
	19	0.098	0.114
	30	0.093	0.107
11	0	0.052	0.056
	11	0.048	0.052
19	0	0.038	0.041
	11	0.036	0.038
22	0	0.034	0.037
	11	0.033	0.035
25	0	0.032	0.034
	11	0.031	0.033
30	0	0.028	0.029
	11	0.027	0.028
38	0	0.024	0.025
	11	0.024	0.024

TABLE 4-2

DEFAULT U-VALUES FOR FLOORS OVER UNVENTED CRAWLSPACE OR BASEMENT

Nominal R-value		U-value	
Floor	**Perimeter**	**Post & Beam**	**Joists**
0	0	0.101	0.119
	11	0.080	0.090
	19	0.076	0.085
	30	0.073	0.082
11	0	0.049	0.053
	11	0.044	0.047
	19	0.042	0.045
	30	0.042	0.044
19	0	0.037	0.040
	11	0.034	0.036
	19	0.033	0.035
22	0	0.033	0.035
	11	0.031	0.033
25	0	0.031	0.033
	11	0.029	0.030
30	0	0.027	0.029
	11	0.026	0.027

TABLE 4-3

DEFAULT U-VALUES FOR FLOORS OVER HEATED PLENUM CRAWLSPACES

Nominal R-value Perimeter	U-value
11	0.085
19	0.075
30	0.069

Note: Crawlspaces used as heated plenums have approximately 30 percent higher heat-loss rate than unvented crawlspaces with the same assumed ACH. Default U-values in Table 4-3 reflect this higher rate of heat loss.

TABLE 4-4

DEFAULT U-VALUES FOR ENCLOSED FLOORS

Nominal R-value		U-value	
Floor	Perimeter	Post & Beam	Joists
0	0.223	21	0.042
11	0.067	22	0.043
13	0.060	25	0.037
15	0.055	30	0.033
19	0.046	38	0.027

CHAPTER 5: ABOVE-GRADE WALLS

5.1 General: Table 5.1 lists heat-loss coefficients for the opaque portion of above-grade walls (BTU/°F-hr per square foot). They are derived from procedures listed in the 1989 ASHRAE Handbook of Fundamentals assuming exterior air films at 7.5-mph wind speed.

Insulation is assumed to uniformly fill the entire cavity and to be installed as per manufacturer's directions. All walls are assumed to be finished on the inside with 1/2-inch gypsum wallboard, and on the outside with either beveled wood siding over 1/2-inch plywood sheathing or with 5/8-inch T1-11 siding. Insulated sheathing (either interior or exterior) is assumed to cover the entire opaque wall surface.

5.2 Framing Description: Three framing types are considered, and defined as follows:

Standard: Studs framed on 16-inch centers with double top plate and single bottom plate. Corners use 3 studs and each opening is framed using 2 studs. Headers consist of double 2X or single 4X material with an air space left between the header and the exterior sheathing. Interior partition wall/exterior wall intersections use 2 studs in the exterior wall.

Framing weighting factors:	Studs and plates	.19
	Insulated cavity	.77
	Headers	.04

Intermediate: Studs framed on 16-inch centers with double top plate and single bottom plate. Corners use 2 studs or other means of fully insulating corners, and each opening is framed by 2 studs. Headers consist of double 2X material with R-10 insulation between the header and exterior sheathing. Interior partition wall/exterior wall intersections are fully insulated in the exterior wall.

Framing weighting factors:	Studs and plates	.18
Insulated cavity		.78
Headers		.04

Advanced: Studs framed on 24-inch centers with double top plate and single bottom plate. Corners use 2 studs or other means of fully insulating corners, and 1 stud is used to support each header. Headers consist of double 2X material with R-10 insulation between the header and exterior sheathing. Interior partition wall/exterior wall intersections are fully insulated in the exterior wall.

Framing weighting factors:	Studs and plates	.13
Insulated cavity		.83
Headers		.04

5.3 Component Description: Default coefficients for three types of walls are listed: single stud walls, strap walls, and double-stud walls.

Single Stud Wall: Assumes either 2x4 or 2x6 studs framed on 16 or 24-inch centers. Headers are solid for 2x4 walls and double 2x for 2x6 walls, with either dead-air or rigid-board insulation in the remaining space.

Strap Wall: Assumes 2x6 studs framed on 16 or 24-inch centers. 2x3 or 2x4 strapping is run horizontally along the interior surface of the wall to provide additional space for insulation.

Double-Stud Wall: Assumes an exterior structural wall and a separate interior, nonstructural wall. Insulation is placed in both wall cavities and in the space between the two walls. Stud spacing is assumed to be on 24-inch centers for both walls.

TABLES 5-1

DEFAULT U-VALUES FOR ABOVE-GRADE WALLS

2 x 4 Single Stud: R-11 Batt

	Siding Material/Framing Type			
			T1-11	
R-value of Foam Board	**Lapped Wood**			
	STD	**ADV**	**STD**	**ADV**
0	.088	.084	.094	.090
1	.080	.077	.085	.082
2	.074	.071	.078	.075
3	.069	.066	.072	.070
4	.064	.062	.067	.065
5	.060	.058	.063	.061
6	.056	.055	.059	.057
7	.053	.052	.055	.054
8	.051	.049	.052	.051
9	.048	.047	.050	.049
10	.046	.045	.047	.046
11	.044	.043	.045	.044
12	.042	.041	.043	.042

NOTE:
Nominal Batt R-value:
R-11 at 3.5-inch thickness

Installed Batt R-value:
R-11 in 3.5-inch cavity

2 x 4 Single Stud: R-13 Batt

	Siding Material/Framing Type			
			T1-11	
R-value of Foam Board	Lapped Wood STD	ADV	STD	ADV
NOTE:	0 .082	.078	.088	.083
Nominal Batt R-value: R-13 at 3.63-inch thickness				
	1 .075	.072	.080	.076
Installed Batt R-value:	2 .069	.066	.073	.070
R-12.7 in 3.5-inch cavity	3 .065	.062	.068	.065
	4 .060	.058	.063	.061
	5 .057	.055	.059	.057
	6 .053	.052	.056	.054
	7 .051	.049	.052	.051
	8 .048	.047	.050	.048
	9 .046	.045	.047	.046
	10 .044	.043	.045	.044
	11 .042	.041	.043	.042
	12 .040	.039	.041	.040

2 x 4 Single Stud: R-13 Blown In Blanket System

	Siding Material/Framing Type			
			T1-11	
R-value of Foam Board	Lapped Wood STD	ADV	STD	ADV
NOTE:				
Nominal Batt R-value	0 .080	.076	.086	.080
R-3.8 per inch thickness				
	1 .074	.070	.077	.074
Installed Batt R-value	2 .068	.065	.071	.068
R-13.3 in 3.5-inch cavity	3 .063	.060	.066	.063
	4 .059	.057	.062	.059
	5 .056	.053	.058	.056
	6 .052	.051	.054	.052
	7 .050	.048	.051	.050
	8 .047	.046	.049	.047
	9 .045	.044	.046	.045
	10 .043	.042	.044	.043
	11 .041	.040	.042	.041
	12 .039	.038	.041	.039

2 x 6 Single Stud: R-19 Batt

	Siding Material/Framing Type					
	Lapped Wood			T1-11		
R-value of Foam Board	STD	INT	ADV	STD	INT	ADV
Nominal Batt R-value R-19 at 6-inch thickness Installed Batt R-Value R-18 in 5.5-inch cavity	0	.062	.058	.055	.065	.061	.058
	1	.058	.055	.052	.060	.057	.055
	2	.054	.052	.050	.056	.054	.051
	3	.051	.049	.047	.053	.051	.049
	4	.048	.046	.045	.050	.048	.046
	.5	.046	.044	.043	.048	.046	.044
	.6	.044	.042	.041	.045	.044	.042
	.7	.042	.040	.039	.043	.042	.040
	.8	.040	.039	.038	.041	.040	.039
	.9	.038	.037	.035	.039	.038	.037
	10	.037	.036	.035	.038	.037	.036
	11	.036	.035	.034	.036	.035	.035
	12	.034	.033	.033	.035	.034	.033

2 x 6 Single Stud: R-21 High Density Batt or Blown In Blanket System

	Siding Material/Framing Type					
	Lapped Wood			T1-11		
R-value of Foam Board	STD	INT	ADV	STD	INT	ADV
Nominal Batt R-value R-21 at 5.5-inch thickness Installed BIBS R-value R-21 in 5.5-inch cavity	0	.057	.054	.051	.060	.056	.053
	1	.054	.051	.048	.056	.053	.050
	2	.050	.048	.045	.052	.050	.047
	3	.048	.045	.043	.049	.047	.045
	4	.045	.043	.041	.047	.045	.043
Installed BIBS R-value R-3.8 per inch thickness BIBS Installed R-Value R-20.9 in 5.5-inch cavity	5	.043	.041	.040	.044	.042	.041
	6	.041	.039	.038	.042	.041	.039
	7	.039	.038	.036	.040	.039	.037
	8	.038	.036	.035	.039	.037	.036
	9	.036	.035	.034	.037	.036	.035
	10	.035	.034	.033	.036	.035	.033
	11	.033	.033	.032	.034	.033	.032
	12	.032	.031	.031	.033	.032	.031

2 x 6 Single Stud: R-22 Batt

	Siding Material/Framing Type					
		Lapped Wood			T1-11	
R-value of Foam Board	STD	INT	ADV	STD	INT	ADV
NOTE:						
Nominal Batt R-value	0	.059	.055	.052	.062	.058	.054
R-22 at 6.75-inch thickness						
	1	.055	.052	.049	.057	.054	.051
Installed Batt R-value	2	.052	.049	.047	.054	.051	.048
R-20 in 5.5-inch cavity	3	.049	.046	.044	.050	.048	.046
	4	.046	.044	.042	.048	.046	.044
	5	.044	.042	.041	.045	.043	.042
	6	.042	.040	.039	.043	.042	.040
	7	.040	.039	.037	.041	.040	.038
	8	.038	.037	.036	.039	.038	.037
	9	.037	.036	.035	.038	.037	.035
	10	.035	.034	.033	.036	.035	.034
	11	.034	.033	.032	.035	.034	.033
	12	.033	.032	.031	.034	.033	.032

2 x 6 Single Stud: 2 R-11 Batts

	Siding Material/Framing Type					
		Lapped Wood			T1-11	
R-value of Foam Board	STD	INT	ADV	STD	INT	ADV
NOTE:						
Nominal Batt R-value	0	.060	.057	.054	.063	.059	.056
R-22 at 7-inch thickness						
	1	.056	.053	.051	.059	.056	.053
Installed Batt R-value	2	.053	.050	.048	.055	.052	.050
R-18.9 in 5.5-inch cavity	3	.050	.048	.046	.052	.049	.047
	4	.047	.045	.044	.049	.047	.045
	5	.045	.043	.042	.046	.045	.043
	6	.043	.041	.040	.044	.043	.041
	7	.041	.040	.038	.042	.041	.039
	8	.039	.038	.037	.040	.039	.038
	9	.038	.037	.036	.039	.038	.036
	10	.036	.035	.034	.037	.036	.035
	11	.035	.034	.033	.036	.035	.034
	12	.034	.033	.032	.034	.034	.033

2 x 8 Single Stud: R-25 Batt

R-value of Foam Board	Siding Material/Framing Type: Lapped Wood STD	Lapped Wood INT	Lapped Wood ADV	T1-11 STD	T1-11 INT	T1-11 ADV
0	.051	.047	.045	.053	.049	.046
1	.048	.045	.043	.049	.046	.044
2	.045	.043	.041	.047	.044	.042
3	.043	.041	.039	.044	.042	.040
4	.041	.039	.037	.042	.040	.038
5	.039	.037	.036	.040	.038	.037
6	.037	.036	.035	.038	.037	.036
7	.036	.035	.033	.037	.035	.034
8	.035	.033	.032	.035	.034	.033
9	.033	.032	.031	.034	.033	.032
10	.032	.031	.030	.033	.032	.031
11	.031	.030	.029	.032	.031	.030
12	.030	.029	.028	.031	.030	.029

NOTE:
Nominal Batt R-value
R-25 at 8-inch thickness

Installed Batt R-value
R-23.6 in 7.25-inch cavity

2 x 6: Strap Wall

	Siding Material/Frame Type: Lapped Wood STD	Lapped Wood ADV	T1-11 STD	T1-11 ADV
R-19 + R-11 Batts	.036	.035	.038	.036
R-19 + R-8 Batts	.041	.039	.042	.040

2 x 6 + 2 x 4: Double Stud

Batt Configuration Exterior	Middle	Interior	Siding Material/Frame Type: Lapped Wood STD	Lapped Wood ADV	T1-11 STD	T1-11 ADV
R-19	------	R-11	.040	.037	.041	.038
R-19	------	R-19	.034	.031	.035	.032
R-19	R-8	R-11	.029	028	.031	.029
R-19	R-11	R-11	.027	.026	.028	.027
R-19	R-11	R-19	.024	.023	.025	.023
R-19	R-19	R-19	.021	.020	.021	.020

2 x 4 + 2 x 4: Double Stud

Batt Configuration			Siding Material/Frame Type			
			Lapped Wood		T1-11	
			STD	ADV	STD	ADV
Exterior	Middle	Interior				
R-11	------	R-11	.050	.046	.052	.048
R-19	------	R-11	.039	.037	.043	.039
R-11	R-8	R-11	.037	.035	.036	.036
R-11	R-11	R-11	.032	.031	.033	.032
R-13	R-13	R-13	.029	.028	029	.028
R-11	R-19	R-11	.026	.026	.027	.026

Log Walls

NOTE:
R-value of wood:
R-1.25 per inch thickness

Average Wall Thickness
90% average log diameter

Average Log Diameter	U-value
6-inch	0.148
8-inch	0.111
10-inch	0.089
12-inch	0.074
14-inch	0.063
16-inch	0.056

Stress Skin Panel

NOTE:

R-value of expanded polystyrene:
R-3.85/inch

Framing: 6%
Spline: 8%
No thermal bridging between interior and exterior splines

Panel Thickness	U-value
3 1/2-inch	.071
5 1/2-inch	.040
7 1/4-inch	.037
9 1/4-inch	.030
11 1/4-inch	.025

CHAPTER 6.0: DOORS

6.1 General: Table 6.1 lists heat-loss coefficients for exterior doors in units of BTU/°F-hr per ft^2 of door. They are derived from data provided in the 1989 ASHRAE Handbook of Fundamentals, Chapter 22, and from a compilation of U-values tested according to AAMA or ASTM standards.

6.2 Component Description: Doors are assumed to be wood or metal with no glazing. These defaults may be used for the opaque portions of doors with less than 50 percent of their total area in glass.

Glazing areas in doors shall use the appropriate default U-value in Chapter 7 for the specific glazing type. Doors with more than 50 percent glazing area are considered entirely window and must use window default U-values in Chapter 7 for the entire door area.

Metal doors are assumed to have thermally broken frames and coefficients include heat loss through frames.

Storm door material is assumed to be the same as the primary door.

6.3 7.5-MPH Adjustment: Coefficients listed under Table 6.1 "15 mph Default Door U-values" shall be used for compliance. When qualifying homes using the Thermal Performance or Energy Budget methods, the Default U-values shall be adjusted to 7.5-mph equivalent values using the following equation:

$$U(7.5mph) = U(15mph) \times 0.931 + .0126$$

where:
U(7.5mph) = default U-value adjusted to 7.5-mph wind speed conditions
U(15mph) = default U-value at 15-mph wind speed conditions

Note: This adjustment is made automatically in the WATTSUN program. Therefore, use the 15-mph U-values when running WATTSUN.

TABLE 6-1: DEFAULT U-VALUES FOR EXTERIOR DOORS
15-mph Default U-VALUES

Type		w/storm
Metal, 1 3/4-inch, solid core urethane flush	0.14	--
Wood, 1 3/8-inch, solid core flush	0.39	0.26
Wood, 1 3/8-inch, solid core panel	0.57	0.33
Wood, 1 3/8-inch, hollow core flush	0.47	0.30
Wood, 1 3/4-inch, solid core flush	0.33	0.28
Wood, 1 3/4-inch, solid core panel	0.57	0.33
Wood, 1 3/4-inch, hollow core flush	0.46	0.29
Wood, 2 1/4-inch, solid core flush	0.27	0.20

TABLE 6-2
GLAZED ENTRY DOOR DEFAULT U-FACTORS

15-mph Default U-factors

	DOOR MATERIAL			
	INSULATED		WOOD	
DESCRIPTION	**35-50% Glass[8]**	**Below 35% Glass**	**35-50% Glass[8]**	**Below 35% Glass**
Single	0.67	0.53	0.81	0.72
Double, Clear 1/4"	0.39	0.31	0.47	0.42
Double, Clear 1/4" + Argon	0.37	0.30	0.45	0.41
Double, Low-e4 1/4"	0.36	0.30	0.44	0.41
Double, Low-e2 1/4"	0.35	0.29	0.43	0.40
Double, Low-e1 1/4"	0.24	0.28	0.41	0.39
Double, Low-e4 1/4" + Argon	0.33	.028	0.41	0.39
Double, Low-e2 1/4" + Argon	0.31	0.26	0.39	0.38
Double, Low-e1 1/4" + Argon	0.31	0.26	0.38	0.37
Double, Clear 3/8"	0.37	0.30	0.45	0.41
Double, Clear 3/8" + Argon	0.36	0.29	0.44	0.41
Double, Low-e4 3/8"	0.34	0.28	0.42	0.40
Double, Low-e2 3/8"	0.33	0.28	0.41	0.39
Double, Low-e1 3/8"	0.21	0.26	0.38	0.37
Double, Low-e4 3/8" + Argon	0.32	0.27	0.40	0.38
Double, Low-e2 3/8" + Argon	0.29	0.25	0.37	0.37
Double, Low-e1 3/8" + Argon	0.29	0.25	0.36	0.36
Double, Clear 1/2"	0.36	.029	.044	0.41
Double, Clear 1/2" + Argon	0.34	0.28	0.42	0.40
Double, Low-e4 1/2"	0.32	0.27	0.40	0.38
Double, Low-e2 1/2"	0.30	0.26	0.38	0.37
Double, Low-e1 1/2"	0.29	0.25	0.36	0.36
Double, Low-e4 1/2" + Argon	0.30	0.26	0.38	0.37
Double, Low-e2 1/2" + Argon	0.28	0.25	0.36	0.36
Double, Low-e1 1/2" + Argon	0.28	0.24	0.34	0.35
Triple, Clear, 1/4"	0.31	0.26	0.39	0.38
Triple, Clear 1/4" + Argon	0.29	0.25	0.37	0.37
Triple, Low-e4 1/4"	0.30	0.26	0.38	0.37
Triple, Low-e2 1/4"	0.29	0.25	0.37	0.36
Triple, Low-e4 1/4" + Argon	0.27	0.24	0.35	0.35
Triple, Low-e2 1/4" + Argon	0.26	0.24	0.34	0.35

1. Subtract 0.02 from the listed U-factors for insulated spacers (fiber glass, wood, butyl or equivalent k-value).
2. Low-e4, emissivity = 0.4 or less: Low-e2, emissivity = 0.2 or less; Low-e1, emissivity = 0.1 or less.
3. Add 0.05 for insulated doors without a thermal break and more than 35 percent glazing.
4. Add 0.06 for insulated doors without a thermal break and less than 35 percent glazing.
5. Add 0.03 for dividers between the glazing with less than 1/8" between the divider and each lite.
6. Argon includes CO_2, SF_6, and argon/SF_6 mixtures.
7. Krypton with a space of 1/4" or more equals argon with a space of 1/2" or more.
8. Use window default U-factors for more than 50% glazing.

CHAPTER 7.0: GLAZING

7.1 General: Table 7.1 lists heat-loss coefficients for exterior windows and skylights in units are BTU/°F-hr per square foot of glazing. They are derived from data provided in the 1989 ASHRAE Handbook of Fundamentals, Chapter 27, the 1958 ASHAE Guide, and a compilation of actual tested U-values taken from the Seattle Department of Construction and Land Use Client Assistance Memo #403 "Glazing U-Values Acceptable For Demonstrating Compliance With The 1986 Energy Code," December 1988.

7.2 Framing Description: Coefficients are listed for framing meeting the following descriptions:

Wood or Vinyl: Wood and vinyl-framed windows having wood and/or vinyl as the primary material of the frame.

Wood with Exterior Aluminum Cladding (Wood w/EAC): Wood-framed windows having an exterior aluminum surface.

Aluminum (Alum): Nonthermally improved metal-framed windows without a thermal break between interior and exterior frame surfaces.

Aluminum with Thermal Break (Alum w/T.B.): Thermally-improved, metal-framed windows having a continuous thermal break with a minimum of 0.25-inches of low-conductivity material installed between the sealed glazing unit and the exterior surfaces of any metal retaining frame, sash, and center pieces (mullions, etc.). If the window is not constructed with a sealed glazing unit, a thermal barrier shall be installed between the layers of glazing.

7.3 Glazing Description: Coefficients are listed for units with a minimum 1/2-inch air space between glazing layers. All coefficients include window-frame and sash heat loss. Window area is based on rough opening dimensions. Storm windows are considered an additional layer of glazing. Windows with metal or other decorative mullions placed between glazing layers must be tested with mullions in place, and are not covered in these default values. Door glazing and side lites are considered windows and calculated separately from the opaque portions of doors. Doors with over 50-percent glazing are considered all window, and shall use window defaults for the entire opaque and nonopaque area. Window default U-values include patio doors, sliding glass doors and storm doors.

2Gl: Double-glazed windows

3Gl: Triple-glazed windows

Ar: Sealed insulated glass unit with argon gas filling the space between glazing layers.

Low-E: Low emittance coating applied to the #2 or #3 glazing surface of a sealed insulated glass unit, or applied to a film suspended between two glazing layers.

7.4 7.5-MPH Adjustment: Coefficients listed under Table 7.1(a) "15 mph Default Window U-values" and "15-mph Default Skylight U-values" shall be used for compliance. When qualifying homes using the Thermal Performance or Energy Budget methods, the Default U-values shall be adjusted to 7.5-mph equivalent values with the following equation:

$$U(7.5mph) = U(15mph) \times 0.931 + .0126$$

where:
U(7.5mph) = default U-Value adjusted to 7.5-mph wind speed conditions
U(15mph) = default U-Value at 15-mph wind speed conditions

Note: This adjustment is made automatically in the WATTSUN program. Use 15-mph U-values when running WATTSUN.

TABLE 7.1

Default U-Factors for Glazing

Window Type	Frame Type			
	Metal	Alum. with Therm. Break	Wood/Vinyl	Al. Clad Wood/ Reinforced Vinyl
Double, clear, 1/4"	0.82	0.66	0.56	0.59
Double, clear, 3/8"	0.78	0.63	0.54	0.57
Double, clear, 1/2"	0.75	0.60	0.50	0.54
Double, Argon, 1/4"	0.77	0.63	0.53	0.56
Double, Argon, 3/8"	0.75	0.60	0.51	0.54
Double, Argon, 1/2"	0.72	0.58	0.48	0.51
Double, Low-e.2, 1/4"	0.73	0.58	0.49	0.51
Double, Low-e.2, 3/8"	0.69	0.54	0.45	0.48
Double, Low-e.2, 1/2"	0.64	0.50	0.40	0.44
Dbl., Low-e.2, Ar., 1/4"	0.66	0.52	0.43	0.46
Dbl., Low-e.2, Ar., 3/8"	0.63	0.49	0.41	0.44
Dbl., Low-e.2, Ar., 1/2"	0.6	0.46	0.37	0.40
Triple, Clear, 1/4"	0.66	0.52	0.42	0.44
Triple, Clear, 1/2"	0.61	0.46	0.37	0.40
Triple, Argon, 1/4"	0.63	0.49	0.39	0.42
Triple, Argon, 1/2"	0.59	0.45	0.36	0.38
Triple, Low-e.2, 1/4"	0.62	0.48	0.39	0.41
Triple, Low-e.2, 1/2"	0.55	0.41	0.32	0.35
Trp., Low-e.2, Ar., 1/4"	0.58	0.43	0.34	0.37
Trp., Low-e.2, Ar., 1/2"	0.52	0.38	0.30	0.32

1. If the Low-e coating has an emissivity greater than 0.2, add 0.03 to the U-factor.
2. If the Low-e coating has an emissivity of 0.1, subtract 0.02 from the U-factor.
3. Subtract 0.02 from the U-factor for windows that have an insulated spacer.

Glass Block	
6"x 6"x4" nominal	0.60
8"x 8"x4" nominal	0.56
12"x12"x4" nominal	0.52

Glazing type	15-mph Skylight U-values Frame type Vinyl or Wood	Wood w/EAC	Alum w/T.B.	Alum
2Gl	0.65	0.69	0.73	0.82
2Gl + Ar	0.60	--	0.70	0.77
2Gl + Low-E	0.52	0.52	0.64	0.70
2Gl + Ar + Low-E	--	0.45	0.50	
3Gl	0.51	--	0.64	
3Gl + Low-E	0.42	--	0.57	--

CHAPTER 8: CEILINGS

8.1 General: Table 8.1 lists heat-loss coefficients for the opaque portion of exterior ceilings below vented attics, vaulted ceilings, and roof decks in units of BTU/°F-hr per square foot of ceiling.

They are derived from procedures listed in the 1989 ASHRAE Handbook of Fundamentals. Ceiling U-values are modified for the buffering effect of the attic, assuming an indoor temperature of 65°F and an outdoor temperature of 45°F.

8.2 Component Description: The three types of ceilings are characterized as follows:

Ceilings Below a Vented Attic: Attic insulation is assumed to be blown-in, loose-fill fiberglass with a K-value of 2.6 Hr-°F-ft2/BTU per inch. Full bag count for specified R-value is assumed in all cases. Ceiling dimensions for flat ceiling calculations are 45 X 30 feet, with a gabled roof having a 4/12-pitch. The attic is assumed to vent naturally at the rate of 3 ACH through soffit and ridge vents. A void fraction of 0.002 is assumed for all attics with insulation baffles. Standard-framed, unbaffled attics assume a void fraction of 0.008.

Attic framing is either standard or advanced. Standard framing assumes tapering of insulation depth around the perimeter with resultant decrease in thermal resistance. An increased R-value is assumed in the center of the ceiling due to the effect of piling leftover insulation. Advanced framing assumes full and even depth of insulation extending to the outside edge of exterior walls.

Vented scissors truss attics assume a ceiling pitch of 2/12 with a roof pitch of either 4/12 or 5/12. Unbaffled standard framed scissors truss attics are assumed to have a void fraction of 0.016.

Vaulted Ceilings: Insulation is assumed to be fiberglass batts installed in roof joist cavities. In the vented case, at least 1.5 inches between the top of the batts and the underside of the roof sheathing is left open for ventilation in each cavity. A ventilation rate of 3 ACH is assumed. In the unvented or dense pack case, the ceiling cavity is assumed to be fully packed with insulation, leaving no space for ventilation.

Roof Decks: Rigid insulation is applied to the top of roof decking with no space left for ventilation. Roofing materials are attached directly on top of the insulation. Framing members are often left exposed on the interior side.

TABLE 8-1: DEFAULT U-VALUES FOR CEILINGS

Ceilings Below Vented Attics

	Standard Frame		Advanced Frame
Flat Ceiling	Baffled	Unbaffled	
R-19	0.049	0.052	0.047
R-30	0.036	0.038	0.032
R-38	0.031	0.034	0.026
R-49	0.027	0.030	0.020
R-60	0.025	0.028	0.017
Scissors Truss			
R-30 (4/12 roof pitch)	0.043	0.049	0.031
R-38 (4/12 roof pitch)	0.040	0.046	0.025
R-49 (4/12 roof pitch)	0.038	0.044	0.020
R-30 (5/12 roof pitch)	0.039	0.046	0.032
R-38 (5/12 roof pitch)	0.035	0.042	0.026
R-49 (5/12 roof pitch)	0.032	0.039	0.020

Vaulted Ceilings

	16" O.C.	24" O.C.
Vented		
R-19 2x10 joist	0.049	0.048
R-30 2x12 joist	0.034	0.033
R-38 2x14 joist	0.027	0.027
Unvented		
R-30 2x10 joist	0.034	0.033
R-38 2x12 joist	0.029	0.027
R-21 + R-21 2x12 joist	0.026	0.025

Roof Deck

	4x Beams, 48" O.C.
R-12.5 2" Rigid insulation	0.064
R-21.9 3.5" Rigid insulation	0.040
R-37.5 6" Rigid insulation	0.025
R-50 8" Rigid insulation	0.019

CHAPTER 9: AIR INFILTRATION

9.1 General: Tables 9.1 and 9.2 list effective air-change rates and heat capacities for heat loss due to infiltration.

Estimated seasonal average infiltration rates in air changes per hour (ACH) are given for the two levels of air-leakage control (see section 4.6 of the Technical Specifications). The energy-effective air-change rate shall be used in calculations for compliance under Thermal Performance or Energy Budgets. Advanced air-leakage control assumes the use of a heat recovery ventilation system providing a continuous airflow of 0.25 ACH with 60 percent heat recovery.

Heat loss due to infiltration shall be computed using the following equation:

$$Q_{infil} = ACH_{eff} * HCP$$

where:

Q_{infil} = Heat loss due to air infiltration

ACH_{eff} = the effective infiltration rate as given in Table 9-1

HCP = the Heat Capacity Density Product for the appropriate elevation or climate zone as given below.

Table 9-1 ASSUMED EFFECTIVE AIR-CHANGES PER HOUR

Air-Leakage Control Package	Air-Changes per Hour Natural	Effective
Standard	0.35	0.35
Advanced	0.10	0.20

Table 9-2 DEFAULT HEAT CAPACITY/DENSITY PRODUCT FOR AIR

Heating Zone	Average Elevation	Heat Capacity/Density
1	Mean Sea Level	0.0180 BTU/Hr-°F
2	2000	0.0168
3	3000	0.0162

CHAPTER 10: MASS

10.1 General: Table 10.1 lists default mass-values for residential construction types. All calculations are based on standard ASHRAE values for heat-storage capacity as listed in 1989 Handbook of Fundamentals, Chapter 22.

Thermal capacity of furniture is ignored, as is heat storage beyond the first 4 inches of mass thickness. All mass is assumed to be in direct contact with the conditioned space. Concrete separated from the heated volume by other materials must multiply the listed concrete mass value by the result of the following formula:

Ln(R-value) x (-.221) + 0.5
Where:

Ln = Natural log
R-value = R-value of material covering concrete

Note: All default values for covered concrete slabs have been adjusted according to this procedure.

10.2 Mass Description: Mass is divided into two types, structural and additional.

Structural Mass: Includes heat-storage capacity of all standard building components of a typical residential structure, including floors, ceilings, and interior and exterior walls in Btu/°F-ft^2 of floor area. It also assumes exterior wall, interior wall and ceiling surface area approximately equals three times the floor area.

Additional Mass: Includes any additional building material not part of the normal structure, which is added specifically to increase the building's thermal-storage capability. This category includes masonary fireplaces, water or Trombe walls, and extra layers of sheetrock. Coefficients are in Btu/°F-ft^2 of surface area of material exposed to conditioned space. The coefficient for water is BTU/°F-Gallon.

10.3 Component Description: Light frame assumes 1-inch thick wood flooring with 5/8-inch sheetrock on ceilings and interior walls, and walls consisting of either 5/8-inch sheetrock or solid logs. Slab assumes a 4-inch concrete slab on or below grade, with 5/8-inch sheetrock on exterior and interior walls and ceiling, and with separate values for interior or exterior wall insulation. Adjustments for slab covering is based on R-value of material. Additional mass values are based on the density multiplied by the specific heat of the material adjusted for listed thickness.

Table 10-1 DEFAULT MASS VALUES

Structural Mass M-value	Btu/°F-Ft^2 floor area
Light frame:	
Joisted/post and beam floor, sheetrock walls and ceilings	3.0
Joisted/post and beam floor, log walls, sheetrock ceilings	4.0
Slab with interior wall insulation:	
Slab, no covering or tile, sheetrock walls and ceilings	10.0
Slab, hardwood floor covering, sheetrock walls and ceilings	7.0
Slab, carpet and pad, sheetrock walls and ceilings	5.0
Slab with exterior wall insulation:	
Slab, no covering or tile, sheetrock walls and ceilings	12.0
Slab, hardwood floor covering, sheetrock walls and ceilings	9.0
Slab, carpet and pad, sheetrock walls and ceilngs	7.0

Additional Mass M-Value	BTU/°F-Ft^2 surface area
Gypsum wallboard, 1/2-inch thickness	0.54
Gypsum wallboard, 5/8-inch thickness	0.68
Hardwood floor	1.40
Concrete/Brick, 4-inch-thickness	10.30
Concrete/Brick, 4-inch-thickness	15.40

	BTU/°F-gallon
Water, 1 gallon	8.0

Conservation and Renewables Discount Program
Specification Changes for FY2005

Mobile Home Weatherization Specifications

Section	Summary	New Spec	Old Spec
No changes were made to these specifications			

MOBILE HOME WEATHERIZATION SPECIFICATIONS[1]
October 1, 2002

PART I-INSTALLATION PROVISIONS

TABLE of CONTENTS

[1] These Mobile Home Weatherization Specifications were prepared by Bonneville in Cooperation with Regional Utilities, Sate Energy Organizations, and Product Manufacturers. These specifications appear in two parts: Part I is the Installation Provisions; and Part II is the Material Provisions

101.000 **INTRODUCTION**

.005 These specifications provide minimum requirements for weatherization in order to claim deemed savings credits under Bonneville Power Administration's Conservation and Renewable Resources Rate Discount Program. Site-built additions shall be weatherized at the same time as the Mobile Home, using the site-built specifications.

.010 The Utility shall provide more descriptive Installer provisions to be used between the Contractor and Installers.

.015 These specifications are based on the most recently published codes and regulations. They are intended to meet or exceed applicable existing codes and regulations. Codes and regulations, however, are updated periodically or changed by State and local jurisdictions. Therefore, the specifications, codes, and regulations shall apply as follows:

.1 Weatherization Measures shall be installed according to these specifications, HUD code, and all applicable State and local codes and Federal regulations, which may include the most recent versions of the Uniform Codes and the National Electric Code;

.2 where State or local code and specification requirements are in conflict, the most stringent requirements shall apply. and

.3 if a specific application is not addressed in the specification, codes, or regulations, the Utility shall determine the appropriate action consistent with the codes and these specifications. Utility decisions in these instances shall be thoroughly documented in the Mobile Home file.

.020 Utilities may add more restrictive requirements than those in this specification and/or add their own requirements.

101.030 **Definitions**
In this specification, the following definitions apply.

101.030.1 **Code**

The most recent applicable Codes which may include HUD Code and the Uniform Codes written by the International Conference of Building Officials (ICBO) including the Uniform Building Code (UBC), the Uniform Mechanical Code (LJMC), Uniform Plumbing Code (UPC), Uniform Fire Code (UFC), and other associated codes and the National Electric Code (NEC) written by the National Fire Protection Association (NFPA) and applicable State codes.

102.000 **SPECIFICATIONS FOR DETERMINING ELIGIBLE MEASURES AND USE OF WEATHERIZATION FUNDS**

.005 The Utility shall determine the weatherization Measures eligible to be installed in each Mobile Home per this specification.

103.000 **GENERAL REQUIREMENTS FOR UTILITIES**

.005 All weatherization shall be completed to provide a safe, permanent, effective, and Workmanlike installation.

.010 Materials, components or products installed under this Program shall meet the criteria defined in the Material Provisions, Part II of this Item.

.015 Materials damaged in shipment or in assembly shall not be used.

.020 Structural members and Building components shall be free of decay and structurally sound before weatherization Measures are installed.

.025 The structure shall be properly supported, leveled and restrained (if required) at the Homeowner's expense before weatherization Measures are installed.

.030 The Utility shall verify that the Installer has indicated, in writing, to the Homeowner or Homeowner Designee the types of materials to be used, methods of installation, identification of special problems, and other information which would minimize misunderstandings. The Utility shall also verify that the Installer has separately identified any unusual (but necessary) costs that affect the price of providing a safe, permanent, effective, and Workmanlike installation.

.035 Weatherization materials, products and labor shall be warranted by the Installer against failure due to manufacturing and installation defects for at least 2 years from the installation date, except that sealed, insulated-glass units shall be warranted against failure of the seal for a minimum of 5 years. The Installer shall provide a written warranty, with the installation date, to the Homeowner or Homeowner Designee. Manufacturers' written warranties may be used by Installers to satisfy a part of this requirement where appropriate.

.040 The Installer is responsible for checking clearances and access to crawl spaces before job commitment, and for making appropriate allowances for ducts, joists, or other installation obstructions.

.045 The Installer is responsible for determining that the ceiling, floor, or wall systems are structurally adequate to support the combined weight of all materials imposed on the ceiling, floor, or wall. The Installer is also responsible for damage incurred during, or as a result of, the installation of any materials and associated work.

.050 Installers shall provide all necessary permits, materials, and labor for installing weatherization Measures in the Residence.

.055 The Utility shall verify the installation of insulation and air sealing by an in-progress inspection or other methods determined to be appropriate by the Utility. The Utility shall document the type of verification in the Consumer's permanent file.

104.000 **INSULATION**

.005 All insulation materials installed under this Program shall meet all applicable material requirements contained in the Material Provisions.

.010 Insulation shall be installed only in areas of the Mobile Home envelope that separate Conditioned Space and unconditioned or outside spaces where none exists or the R-value *is less* than that prescribed in this specification.

.015 The Utility shall maintain a copy of an Installer certificate for blown-in insulation in the Consumer's permanent file which contains the following information when insulation is installed in ceilings, walls, and/or floors:

.1 Address of the Residence;
.2 date of Installation;
.3 name and Address of Installer;
.4 the estimated R-value of any existing insulation;

.5 the amount, R-value, depth and type (including product name) of insulation installed by the Installer;
.6 final R-value of insulation; and
.7 area of the space (in square feet) insulated.

.020 Exhaust-fan ducts terminating in ceiling cavities, crawl spaces, or other spaces, shall be extended through to the outside, and sealed to prevent exhaust air from returning back into the space.

104.100 **Health and Safety Requirements**

.105 After installation, insulation materials, including facings, (except foam-plastic insulation--Specifications 104.115 and 104.120) shall meet the installation requirements of the Uniform Building Code 1713(c). Flame spread and smoke developed limitations do not apply to facings, IF the facing is installed in substantial contact with the unexposed surface of the ceiling, floor, or wall finish.

.110 Recessed lighting fixtures and fan/light combinations that are Type-IC rated by UL may be covered with insulation. Fan/heater, fan/light/heater, and light/heater combinations may be covered with insulation IF they are rated "Heater" or "Air Heater."

.115 Ventilation fans may be covered with insulation IF all holes and penetrations are sealed with a nonflammable sealant.

.120 Only fluorescent fixtures with appropriate thermal protection shall be covered with insulation.

.125 Thermal insulation shall not be installed within 3 inches of fans, lights, and heaters that do not meet the requirements of 104.110 through 104.120 and other heat producing fixtures, and shall not be installed so as to entrap heat and prevent the free circulation of air (NEC 410-66). Solid, flame-resistant baffles attached to the ceiling structure shall be used to maintain required clearances. Fixtures may be replaced with fixtures rated as Type-IC, Heater, or Air Heater at the homeowner's expense.

All combustible insulation materials shall be kept at least 2 inches from metal flues and chimneys. Noncombustible insulation may be installed with no clearance around flues and chimneys if permitted by local or State fire code. However, if the flue is a single-wall type (i.e., made from a single thickness of rolled sheet metal), a 2-inch air clearance to all insulating materials shall be maintained. Noncombustible insulation material conforms to the ASTM E-136-82 standard test method.

.130 Kitchen-range exhaust fans vented through the coiling shall be connected to a duct of not less than 30-gauge galvanized steel (UMC Chapters 10 and 11) which is substantially airtight throughout and which terminates directly to the outside in a vent cap. Operable, functional backdraft dampers are required. Existing installations that substantially meet these requirements are acceptable.

.135 Kitchen-range exhaust fans which are vented to the crawl space shall be ducted through the skirting according to the manufacturer's instructions.

.140 Insulation shall not be installed in wall cavities which contain electric space heaters unless fire stops are present which isolate the heater from all contact with the insulation material. Verification shall be accomplished by removing the heater after the insulation is installed.

.145 Pipe insulation shall not be installed on pressure/temperature relief valves, on the operating portion of any valves, or on any other control and safety devices.

.150 Exposed facings or protective coverings used on pipe or duct insulation shall meet Code flame-spread and smoke-development requirements.

.155 When water-pipe heaters are used for freeze protection, they shall include a thermostat set at approximately 35 degrees Fahrenheit.

.160 All combustion appliances, except gas cooking appliances and gas clothes dryers, shall have outside combustion air ducted directly to the appliance. Fireplaces and wood-burning stoves shall have tight-fitting glass or metal doors that cover the entire opening of the firebox.

.165 All aluminum wiring should be tightened at switch and outlet connections.

104.200 **Installation Provisions for Ceiling Cavities-Mobile Homes**

.205 Ceiling cavities under flat or crowned metal roofs shall be insulated by completely filling them with blown-in insulation and sealing all existing attic ventilation except existing roof jacks. It is recommended that this application be done in conjunction with Section 104.300 because of concerns about the potential for moisture condensation.

.210 Ceiling cavities under flat or pitched roofs shall be insulated to R-38 or to the maximum practical R-value, and ventilated to 1 ft^2 for each 300 ft^2 of ceiling area.

.215 All penetrations through the ceiling shall be sealed before ceiling cavities are insulated.

.220 If the ceiling cavity contains a non-ducted return-air system, the return-a system shall be eliminated as described in Section 104.1430.

104.300 **Installation Provisions for Roofs-Exterior Surface, Mobile Homes**

.305 If exterior roof insulation is installed, it shall be a minimum of R-7. Exterior roof insulation shall not be installed over ventilated ceiling cavities or over cavities containing air spaces.

.310 Roof drainage systems shall function properly after weatherization has been installed.

.315 .Weatherproof roof coverings shall be applied directly over the insulation. Costs associated with providing a weatherproof roof or roof membrane shall not be covered under this Program.

.320 All penetrations through the roof covering and all joints between the roof covering and vertical surfaces (e.g. walls, chimneys, etc.) shall be flashed.

.325 Other methods of installing exterior roof insulation shall be approved by the Contractor in writing prior to beginning the work.

104.400 **Installation Provisions for Ramada Roofs-Mobile Homes**

.405 A ramada roof is a free standing (self supporting) covering over a Mobile Home.

.410 The ramada roof shall be joined to the Mobile Home to create an enclosed attic cavity at the homeowner's expense. The ramada roof shall be weatherproof and be joined to prevent the entry of birds, animals, etc.

.415 The attic cavity shall meet the ventilation requirements of the site-built specifications.

.420 All exhaust-fan ducts, plumbing vent stacks, etc. shall be extended outside and have a proper termination.

.425 All heat producing fixtures shall be protected according the site-built weatherization specifications.

.430 The original roof cap of the Mobile Home shall be opened to allow a full fill of insulation inside the cap. Insulation shall be installed above the original roof to provide an installed level of R-38. The openings in the original roof shall NOT be sealed.

.435 All penetrations through the ceiling shall be sealed before the insulation is installed.

104.600 **Installation Provisions for Underfloors-Mobile Homes**

.605 All HVAC ducts and plenums shall be inspected for leaks or openings, and all leaks or openings repaired and sealed, before underfloor insulation is installed. Non-ducted return-air systems in the floor cavity shall be eliminated. See Section 104.1400.

.610 All plumbing penetrations through the floor (e.g., bathtubs, clothes washers, sinks, etc.) shall be sealed before underfloor insulation is installed.

.615 Insulation shall be protected by a moisture permeable covering or skirting shall be installed at the homeowner's expense before underfloor insulation is installed. Skirting shall be as close to the ground as practical.

.620 A minimum of R-19, or the maximum R-value achievable to fill the floor cavity, shall be installed. Special care shall be taken when insulating the floors of tip-outs or expandos.

.625 Where required by State or local codes, a moisture permeable rodent barrier shall be in place and in good repair after the insulation is installed.

.630 All exhaust ducts, such as those for kitchen ranges and dryers, shall be extended to the outside of the crawl space and sealed to prevent exhausted air from returning to the crawl space and/or the Mobile Home when skirting exists.

.635 All water drains, including condensate drains from air conditioning equipment, shall be extended outside the crawl space.

.640 All water pipes that have not been insulated by the floor insulation, shall be insulated to at least R-3 for freeze protection. Water-pipe insulation costs shall be included with underfloor insulation and be installed according to Specification 104.1600.

.645 Water-pipe heaters may be installed in localities with sustained periods of subfreezing winter temperatures. Such heaters shall include a thermostat set at approximately 35 degrees Fahrenheit. They shall be placed around all water pipes (both hot and cold water) in the crawl space, inside the pipe insulation, and in contact with the pipe surface. Such installations shall conform to the National Electric Code and any applicable State or local code.

.650 Underfloor insulation support systems shall be installed so that the insulation remains in contact with the sub-floor, flat and in place for the life of the Residence. Support of the insulation may be provided by wood lath, twine, wire, or other material as approved by the Utility.

.655 Vapor retarders installed as a part of floor insulation shall have a perm rating of 1.0 or less and shall be located between the insulation material and the Conditioned Space.

.660 After underfloor insulation has been installed, an acceptable ground-cover moisture barrier shall be present (new 6 mil black polyethylene or existing 4 mil polyethylene) where skirting exists. All joints shall be overlapped with sufficient material so that all ground surface area is covered.

Ventilation Requirements

.665 When skirted, the entire enclosed underfloor crawl space area shall be ventilated by openings in the skirting. Such openings shall have a net area of not less than 1 square foot for each 150 square feet of underfloor area, including the crawl space area of all structures which open to that of the Mobile Home.

Where moisture due to climate and groundwater conditions are not considered excessive, the Utility may allow operable louvers and may allow the required net area of vent opening to be reduced to 1/300 or less (minimum 1/1500), provided the underfloor ground-surface area is covered with an approved ground cover. Openings shall be located as close to corners as practical and shall provide cross ventilation. The required area of such openings shall be approximately equally distributed along the length of at least two opposite sides. They shall be covered with corrosion-resistant wire mesh with maximum mesh openings of 1/4-inch. Existing vent openings which are covered with wire mesh need not be modified.

.670 If crawl space ventilation cannot be installed to meet these requirements, underfloor insulation shall <u>not</u> be installed.

104.1300 **Installation Provisions for Exterior Wall Cavities-Mobile Homes**

.1305 Wall cavities shall be completely filled with blown-in or batt insulation to the highest practical R-value and all wall penetrations shall be sealed. The bottom outside edge of ventilated walls shall **<u>NOT</u>** be sealed.

.1310 Blown-in insulation shall be installed using an insert-tube. Other installation methods, such as batt stuffing may be approved by the Contractor.

.1320 The Contractor shall verify the installation of insulation by an in-progress inspection or other methods determined to be appropriate by the Contractor. The Contractor shall document the type of verification in the Consumer's permanent file.

104.1400 **Installation Provisions for HVAC Ducts-Mobile Homes**

.1405 All HVAC ductwork, including plenums, shall be repaired, sealed and properly supported before underfloor insulation is installed.

.1407 All new and all accessible existing HVAC supply and return ducts, air handlers, and plenums inside and outside the heated space shall be sealed at all joints and corners, including prefabricated joints, with duct mastic. Tape is not allowed except for use on operable doors in the system such as on the air handler. In this case, foil tape with a 15-

mil butyl sealant shall be used; alternately, the joints can be cleaned with a suitable solvent and sealed with a UL-181 listed tape.

.1410 Any portion of an HVAC duct that extends beyond the last register shall be sealed.

.1415 The crossover ducts shall be installed to prevent compressions or sharp bends, minimize stress at the connections, avoid standing water, and avoid excessive duct lengths. When skirting is not present, the crossover duct shall be protected against rodents, pets, etc.

.1420 Flexible crossover ducts shall have a minimum R-8 insulation. They shall be secured with mechanical fastners (e.g., stainless steel worm drive clamps, plastic/nylon straps applied with tightening tool, etc.) and sealed with mastic or aluminum/foil backed butyl or equivalent sealant tape. Existing flexible crossover duct with an insulation value of R-4 or less and which has been damaged may be replaced with new flexible duct with an insulation value of R-8.

.1425 Where clearances permit, the crossover duct shall be supported above the ground by strapping or blocking.

104.1430 If a nonducted return-air system is in the floor or ceiling cavity, it shall be eliminated. Seal all return-air openings in the floor or ceiling and Seal the main return-air opening in the floor or ceiling of the furnace closet. Return air shall be provided through grills in the furnace closet to the heated space. These grills shall be adequately sized for the installed heating system. All interior doors shall be undercut to allow return air to flow back to the furnace closet.

.1435 If the belly board/rodent barrier has been removed and batt insulation has been installed in the floor, all HVAC ducts, boots and plenums, except flexible crossover ducts, shall be wrapped with R-11 insulation.

104.1600 **Installation Provisions for Water Pipe Insulation-Mobile Homes**

.1605 Water pipes that have not been covered by underfloor insulation shall be insulated to a minimum of R-3.

.1610 The piping shall be free from water leaks and properly secured to support the weight of the piping and insulation.

.1615 The product may be either flat and capable of being molded to the outside surface of common pipe sizes, or preformed to fit standard pipe diameters. If the product is preformed, dimensions shall be appropriate for the pipe size intended to be insulated.

.1620 If insulation is installed on piping exposed to the weather, it shall be resistant to degradation from moisture, ultra-violet light, and extremes in temperature, or a jacket or facing shall be installed that protects the insulation from these conditions. Manufacturer's recommendation for outdoor installations shall be followed in all cases.

105.000 **INSTALLATION PROVISIONS FOR PRIME WINDOWS -MOBILE HOMES**

.005 Storm windows, vent conversions and fin-bar conversions are not acceptable under this program. New prime windows and patio doors (French or Sliding) that are Energy Star labeled for the Northern Climate Zone may replace existing dual-glazed windows in non-wood or vinyl framed windows or single-glazed windows regardless of frame type.

105.400 **General Installation Provisions**

.405 Window frames shall be permanently affixed to the Residence. Upon installation completion, units shall operate smoothly and properly. Hardware shall be durable, and function properly.

.415 Correct size, shape, and type of windows for the openings shall be assured by the Installer. Each one shall be Measured for appropriate clearances and "out-of-squareness." The window may need to be adjusted to be square, plumb, and level without distortion to the window parts, upon installation.

.420 Any installation that results in increased window area shall not be allowed under this Program.

.425 No windows shall have exposed burrs, sharp corners or other conditions that could cause injuries to the occupants during normal use.

.430 All replacement prime windows shall be NFRC labeled and certified and meet the Energy Star requirement with a maximum U-factor of 0.35.

.435 Installation procedures shall ensure that the integrity of the multiglazed seal is maintained.

.440 Glazing compounds shall not contact the seal of the multiglazed unit or the material shall be shown to be chemically compatible with the seal of the multiglazed unit.

105.500 **Health and Safety Requirements**

.505 Safety glass shall be used under the following conditions:

.1 Glazing in entrance doors.

.2 Glazing in fixed and sliding panels of sliding doors and panels in swinging doors other than wardrobe doors.

.3 Glazing in fixed or operable panels adjacent to a door where the nearest exposed edge of the of the glazing is within a 24-inch arc of either vertical edge of the door in a closed position and where the bottom edge of the glazing is less than 60 inches above the floor or walking surface unless there is an intervening wall or permanent barrier between the door and the glazing.

.4 Glazing in an individual fixed or operable panel other than those covered by 105.505.3 above that meet ALL of the following conditions:

a. Have an exposed area of an individual pane greater than 9 square feet.
b. Has an exposed bottom edge is less than 18 inches above the, floor.
c. Has an exposed top edge greater than 36 inches above the floor.
d. Has one or more walking surfaces within 36 inches horizontally of plane of glazing.

In lieu of safety glazing, such glazed panels may have a protective, bar installed on the accessible sides of the glazing 34 to 38 inches above the floor. The bar shall be capable of withstanding a horizontal load of 50 pounds per linear foot without contacting the glass and be a minimum of 1 1/2 inches in height.

.5 Glazing in any portion of a building wall enclosing showers, hot tubs, whirlpools, saunas, steam rooms, and bathtubs where the bottom exposed edge of the glazing is less than 5 feet above a standing surface and drain inlet.

Each pane of each safety glass lite shall be marked with the name of the manufacturer and place of manufacture, and shall certify compliance with all applicable -,standards for the manufacture and testing of safety glass (e.g., CPSC Class 2).

.515 Retrofitted vertically-opening prime windows shall not free fall.

106.000 INSTALLATION PROVISIONS FOR DOORS-MOBILE HOMES

RESERVED

107.000 INSTALLATION PROVISIONS FOR AIRSEALING-MOBILE HOMES

107.100 Prescriptive Airsealing

.105 All gaps, holes, joints and seams in HVAC ducts and plenums shall be sealed. This includes blocking off all ducts just beyond the last register, sealing all joints from the furnace to the plenum, the plenum to the main duct, the boots for each register to the main duct, the boots for each register to the floor. Seal all branch-duct to main-duct connections when necessary.

.110 All gaps and holes where HVAC ducts, plenums and registers penetrate the envelope shall be sealed.

.115 All plumbing penetrations, including those in water heater closets, shall be sealed. Place special emphasis on penetrations for bathtub, sink, and clothes washer drains.

.120 All gaps between exhaust-fan ducts and the envelope, including those, for kitchen ranges, bathrooms and clothes dryers, shall be sealed. All exhaust ducts shall have functional, operable backdraft dampers.

.125 All gaps between the ceiling for swamp cooler ducts shall be sealed.

.130 The entire length of marriage lines and the jointsfor tip-outs, expandos and add-on rooms shall be sealed.

.135 All electrical penetrations, including the electrical service panel shall be sealed.

.140 All air bypasses in electrical/plumbing chases and around chimneys, flues, etc., except for single-wall metal flues, that penetrate floors and ceilings shall be sealed with 5/8-inch, Type-X sheet rock.

109.000 INSTALLATION PROVISIONS FOR CLOCK THERMOSTATS-MOBILE HOMES

.005 Clock thermostats may be installed when determined to be appropriate by the Utility. Existing thermostats on the exterior wall shall have the wiring provided on an interior wall at the homeowner's expense before a clock thermostat can be installed.

109.100 **Installation Provisions**

.105 Clock thermostats shall be installed in compliance with local codes and the manufacturer's instructions.

.110 The Installer shall provide written instruction materials to the Homeowner or Homeowner Designee. The Installer shall also explain the clock thermostat's operation and method of adjustment to one or more members of the Residence.

111.000 **INSTALLATION PROVISIONS FOR ELECTRIC WATER HEATER CLOSETS-MOBILE HOMES**

.005 The exterior access door and associated exterior walls of closets containing electric water heaters shall be insulated to a minimum of R-11. The water heater shall NOT be wrapped.

.010 The exterior door to closets containing electric water heaters shall be weatherstripped, and any existing ventilation vents shall be sealed.

.015 All penetrations through the walls, ceilings, or floors of the water heater closet shall be sealed.

.020 For gas-fired water heaters, the walls of the water heater closet adjacent to heated space shall be insulated and combustion air vents shall not be sealed. The exposed surfaces of the insulation shall have a flame spread rating of 25 or less and maintain code required clearances to the furnace.

114.000 **MECHANICAL VENTILATION**

.005 A mechanical ventilation system meeting either the requirements of 114.100, 114.200, 114.300, or 114.400 shall be installed in all homes.

.100 **Non-Heat-Recovery Ventilation - Intermittent Operation**

.105 A bathroom exhaust fan is controlled by both a manual switch, crank timer or dehumidistat in the bathroom to provide spot ventilation AND a time clock to provide whole-house ventilation when called for by the timer. Outside-air inlets in all living areas and bedrooms, and undercut doors, grilles, transoms, or other approved means provide fresh-air circulation through the house to the bath fan.

.110 Exhaust ducts shall be smooth metal and terminate outside the house at the closest possible location. All connections shall be tight fitting and taped or sealed, and backdraft dampers shall be provided.

.115 The minimum exhaust airflow rates shall comply with either the performance OR prescriptive paths listed below. Surface-mounted fans shall have a sone rating of 1.5 or less, or other rating as approved by the Contractor. Existing fans that meet the minimum airflow rates are exempt from the sone rating requirement.

1. **Performance Path:** The minimum measured airflow capacity shall

Number of Bedrooms		Measured Exhaust Flow
1		45 cfm
2		60 cfm
3		75 cfm
4		90 cfm

To calculate the ACH for a fan with a MEASURED airflow of 45cfm multiply by 60 to obtain the airflow per hour (45 X 60 = 2700 cfh) and divide by the volume of the heated space.

2. **Prescriptive Path:** Ventilation systems that do not meet the performance path shall provide 0.35 ACH based upon the rated fan flow minus 15 cfm or use the rated fan flows in the following table:

Number of Bedrooms		Rated Fan Flow
1		70 cfm
2		85 cfm
3		100 cfm
4		115 cfm

To calculate ACH based on the RATED airflow, subtract 15 cfm, multiply by 60, and divide by the volume of the heated space.

.120 The fan shall have both automatic and manual controls. Automatic controls shall include a time clock or cycle timers with a minimum of 2 on-periods per day, a manual control switch to lot the occupant turn the fan on or off, and be set to operate a minimum of 8 hours per day.

.125 The ventilation fan shall be wired to both the manual spot-ventilation switch in the bathroom and to a time clock.

.130 Individual outside-air inlets, located to avoid drafts, shall provide a minimum of 4 sq. inches per bedroom and combined living area.

If a whole house blower door test, in accordance with Appendix T and conducted after air sealing measures are installed, results in an $ACH_{50} \div 20$ greater than 0.35 and the house has no combustion appliances capable of backdrafting (i.e. naturally vented or atmospheric chimneys) within the exterior shell of the house, outside-air inlets may be omitted.

.135 The outside-air source shall be located at least 3 feet from exhaust vents and to minimize drawing outdoor pollutants and excessive outdoor noise inside during operation.

.140 The outside-air source shall limit excessive airflows during normal operation and have a weather protection hood and maximum 1/4" screen-mesh, or as approved.

114.200 **Unbalanced Non-Heat-Recovery Ventilation-Continuous Operation**

.205 This system uses a continuously-operating fan to exhaust air at a minimum rate of 25 cfm for the kitchen, and 20 cfm for each bathroom, with a maximum rate of 0.5 ACH. One

fan exhausting from the kitchen and each bathroom also provides spot ventilation. An integrated spot and whole-house fan is acceptable if spot ventilation is also provided for the kitchen and for the bathrooms. .

.210 The exhaust-air pickup in the kitchen shall not be over the kitchen range.

.220 If the exhaust flow from each kitchen and bathroom is not measured, the rated fan capacity shall exceed the required flow rate by a minimum of 15 cfm.

.225 The continuous ventilation fan(s) shall be wired to an existing circuit or to the electrical service panel.

.230 The outside-air inlet and source requirements shall be the same as Sections 114.105, 114.130, 114.135, and 114.140.

114.300 **Balanced Flow Non-Heat Recovery Ventilation-Continuous Operation**

.305 Balanced flow non-heat-recovery air exchange units shall:

1. have fans capable of providing the intake and exhaust airflow rates in section 114.115 at 0-25 inches of water gauge as determined by HVI 916 (July 1993);

2. provide complete isolation of the intake and exhaust air;

3. have UL approval of all electrical components (see Specifications Nos. 210.030, .035, .040, .045 for more information);

4. have outside-air inlets in all living areas and bedrooms, positioned so-as-to avoid drafts; and

5. be installed according to the manufacturers instructions.

114.400 **Air-to-Air Heat Exchangers**

.405 Air-to-air heat exchangers shall:

1. Provide the ventilation rates in Section 114.115;
2. have a minimum sensible heat recovery efficiency of 65 percent at 117 cfm and 32°F for homes larger than 1300 $ft \cdot^2$ and 55 percent at 64 cfm and 32°F for houses of 1300 ft^2 or less as certified by the Home Ventilation Institute (HVI);
3. have a filter on the upstream side of the heat exchanger in both the intake and exhaust airstreams;
4. provide protection against ice buildup that does not disable the unit during freezing weather; and
5. be installed according to manufacturer's instructions.

114.500 **Other Mechanical Ventilation Systems**

.505 Other mechanical ventilation systems meeting the Super Good Cents for Manufactured Housing specifications may be used if approved by Bonneville.

PART II-MATERIAL PROVISIONS

TABLE OF CONTENTS

202.000 GENERAL MATERIAL PROVISIONS

.005 Materials, components or products installed under the Conservation and Renewable Resources Rate Discount Program (C&R Discount Program) shall meet the criteria defined is this specification. Materials, components or products shall be submitted to the Utility or Bonneville for evaluation and have written acceptance before installation. Product evaluation shall be based on test results from a mutually acceptable independent laboratory indicating compliance to the requirements in this specification.

.010 The Utility or Bonneville reserves the right to identify and disapprove for use in the C&R Discount Program, any weatherization product at any time when it deems the product not satisfactory for the C&R Discount Program.

.015 Where written acceptance of materials, components, or products is required, the intent is that, unless otherwise stated in the specification or the acceptance, once it is accepted by a Utility or Bonneville, for one installation, the material, component, or product shall be acceptable for all other similar installations without resubmittal to the Utility or Bonneville except as noted in Specification 202.010 above.

.020 . The Utility may decide that a product or its installation is unsatisfactory after an inspection is performed even if that product has been accepted previously by the Utility or Bonneville. A rejection based on the installation may require the Installer to correct the work done. Also, the Utility has the right to disapprove the use of the product on all future jobs.

Such disapproval shall be, issued in writing and shall identify the flaws found in the product or its installation. The Utility shall notify Bonneville, of any products which are disapproved.

.025 All materials used under the C&R Discount Program shall be resistant to corrosion, degradation from ultraviolet light, and be compatible with other elements and materials (will not react chemically, etc.,) to enhance the life expectancy of installed Measures.

204.000 **INSULATION MATERIAL PROVISIONS**

.005 The American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Handbook of Fundamentals (1989 or later) is the accepted standard for R-value/U-value of materials used by Installers. Products that vary from ASHRAE may be acceptable if they comply with current Federal Trade Commission (FTC) certifications, testing and labeling rules, and have independent laboratory testing which indicates the product's R-value/U-value.

204.010 All thermal-insulation materials shall meet the requirements of Sections 1712 and 1713 of the UBC and those in the applicable Federal specifications listed below.

.1	Mineral Fiber Blankets/Batts	HH-1-521F
.2	Mineral Fiber Loose-Fill	HH-1-1030B
.3	Cellulose Loose-Fill	ASTM C-739-86
		16 CFR 1209
		16 CFR 1404
.4	Perlite	ASTM C-549-81
.5	Vermiculite	ASTM C-516-80
.6	Polystyrene Board	ASTM C-578-87A
.7	Polyurethane and	
	Polyisocyanurate Board	HH-1-530B

.015 In addition, loose-fill cellulose manufacturers shall subscribe to an ongoing laboratory quality control inspection Program substantially equivalent to the "UL classification" Program. This Program periodically verifies the manufacturer's adherence to the requirements of CPSC cellulose regulation 16 CFR 1209 (i.e., critical radiant flux, smoldering combustion, settled density, and corrosiveness).

Also, the UL or equivalent label shall appear on every bag of material. It shall include the file number (R-number) of the manufacturer and the issue number for labels purchased.

.020 All insulation materials installed shall meet the requirements of the Federal Trade Commission Labeling Rule (16 CFR 460). Additional labeling on weatherization materials may be required under the RCS regulations for. covered utilities.

.025 Urea-Formaldehyde foam insulation is not acceptable.

.035 Duct insulation for use in unconditioned areas on ducts not subject to routine human contact shall meet the requirements of Federal Specification HH-1521F, any type.

For ducts subject to routine human contact during servicing or storage activities, (e.g., in garages, basements, attics used for storage) the insulation shall meet HH-1-521F and

either be classified as Type 2 or 3, Class A (reflective or non-reflective, flame rated, faced batts) material. Faced material shall have a covering which provides physical protection to the insulation and has a flame spread of 50 or less when tested in accordance with ASTM E-84-88 when used on duct systems which serve single Residences only.

In Buildings having a duct system which serves more than one Residence, the covering shall have a flame spread of 25 or less when tested in accordance with ASTM E-84-80.

.040 Pipe insulation shall meet the following provisions:

1. Pipe insulation materials shall be comprised of mineral fiber, elastomers, urethanes, isocyanurates, or other suitable materials.

.2 The material shall be capable of withstanding continuous operating temperatures of not less than 180 degrees Fahrenheit.

.3 The product shall be finished with a jacket or facing, suitable to resist damage and degradation. However, if the product is made of closed cell foam and is installed in a location protected from moisture, ultraviolet light and extremes in temperature, a protective jacket or facing is not required.

.4 The insulation material, any jackets or facings, and adhesive, if used, shall be tested as a composite product and shall have a flame spread rating of 25 or less, and a smoke density of 50 or less when tested according to ASTM E-84-88.

205.000 WINDOW MATERIAL PROVISIONS

.005 Prime replacement windows shall meet the Energy Star specifications for the Northern Climate Zone and shall be NFRC labeled and certified to have a maximum U-factor of 0.35.

.030 Meeting rails of movable windows shall be provided with a durable, effective, infiltration barrier and shall include a mechanical interlock or equivalent mechanism. All sliding panes or associated channels shall be fitted with infiltration and weather barrier devices.

.035 Vertically-moving windows shall hold the sash secure and level in ventilating positions.

.050 Security latches are required on all prime window replacements.

.060 Each safety-glass lite shall be marked with the name of the manufacturer and place of manufacture, and shall certify compliance with all applicable standards for the manufacture and testing of safety glass (e.g., CPSC Class 2).

206.000 DOOR MATERIAL PROVISIONS

RESERVED

207.000 WEATHERSTRIPPING MATERIAL PROVISIONS

.005 Products used in the Program shall be designed to resist deterioration when subjected to sunlight, moisture, other weather conditions, and normal use.

.010 Weatherstripping shall be of the following types:

.1 Hollow, cold weather, vinyl tube type or vinyl-silicone composite material which is affixed to a prepunched aluminum flange or extrusion;

.2 spring metal cushion weatherstrip;

.3 cold weather vinyl type or vinyl-silicone composite material which is affixed to a prepunched aluminum flange, or extrusion;

.4 interlocking metal weatherstrip;

.5 two-piece, magnetic bellows-type weatherstrip;

.6 vinyl bulb or vinyl-silicone composite material with a semirigid flange; or

.7 polypropylene replacement pile.

Other types of weatherstripping material shall be submitted to the Contractor for examination and written approval prior to use.

208.000 **CAULKING MATERIAL PROVISIONS**

.005 Caulking shall be one of the following materials conforming to the Federal Specifications listed below or material demonstrating equivalent performance in resiliency and durability:

.1	Silicone Rubber	TT-S-1543A
.2	Polysulfide or Polyurethane (single component)	TT-S-230C
.3	Polysulfide or Polyurethane (multiple component)	TT-S-227E
.4	Acrylic Terpolymer (single component)	TT-S-230C
.5	Butyl Rubber	TT-S-1657
.6	Acrylic Latex	ASTM C834-76

208.010 The cartridge or tube containing the caulking material shall be labeled in indicating conformance to the applicable Federal Specification.

209.000 **CLOCK THERMOSTAT MATERIAL PROVISIONS**

.005 The clock thermostat ("low-voltage" and "line voltage" types) shall meet the requirements of NEMA DC 3-1984.

.010 The clock thermostat shall be easily Programmable by the Homeowner or Homeowner Designee and shall be at least a 24-hour type. Seven day clocks are preferred. In addition, the thermostat shall allow for at least two separate setback periods per day (i.e., day as well as night setback). Where central air conditioning (or a heat pump) is present, the thermostat shall allow for summer "setup" as well as winter "setback" control.

.015 The clock thermostat shall have independent adjustment capability for the "high" and "low" temperature set points.

.020 Thermostats used with heat pumps shall be capable of restricting the use, of electric resistance elements during the normal temperature pickup periods. Such thermostats shall be designed so that the temperature pick up is accomplished by using heat pumping as much as possible and electric resistance elements only when necessary. This may be accomplished either by inhibiting electric resistance elements or by applying an electronic control technique which allows for the operation of electric resistance elements only when the beat pump will be unable to attain the setpoint within a suitable recovery time. The Contractor or Bonneville shall approve each heat pump thermostat model, in writing, prior to installation.

.025 Line voltage clock thermostats shall be tested and meet minimum performance requirements of Canadian Standards Association C273.4-MI978 or other equivalent test procedures and standards.

214.000 **CROSSOVER DUCT MATERIAL PROVISIONS**

.005 Crossover ducts shall have a minimum labeled insulation of R-8 and shall have an exterior vapor retarder rated at 1.0 perms or less.

.010 Crossover ducts shall have an inner liner material which includes a spring-steel wire helix bonded within two layers of 57-gauge or thicker mylar film.

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Conservation and Renewables Discount Program Specification Changes for FY2005

Site Built Housing Weatherization Specifications

Section	Summary	New Spec	Old Spec
No changes were made to these specifications			

SITE BUILT HOUSING WEATHERIZATION SPECIFICATIONS[i]
October 1, 2003
PART I--INSTALLATION PROVISIONS

Index to Sections

[i] These Site Built Housing Weatherization Specifications were prepared by Bonneville in Cooperation with Regional Utilities, State Energy Organizations, and Product Manufacturers. These specifications appear in three parts: Part I is the Installation Provisions; Part II is the Material Provisions; and Part III contains the appendices.

101.000 **INTRODUCTION**

.005 These specifications provide minimum requirements for weatherization in order to claim deemed savings credits under Bonneville Power Administration's Conservation and Renewable Resources Rate Discount Program.

.010 Utilities shall provide more descriptive Installer provisions to be used between the Utility and Installers.

.015 These specifications are based on the most recently published codes and regulations and are intended to meet or exceed applicable existing codes and regulations. Codes and regulations, however, are updated periodically and are also subject to change through the code processes at State and local jurisdictions. Therefore, the specifications, codes, and regulations shall apply as follows:

.1 Weatherization Measures shall be installed in accordance with these specifications, all applicable State and local codes and Federal regulations, and the most recent versions of the Uniform Codes and the National Electric Code;

.2 where State or local code and specification requirements are in conflict, the most stringent of the requirements shall apply. When State or local codes are less restrictive, Bonneville may approve their use in lieu of these specifications. Such approval must be requested in writing by the Utility and approved in writing by Bonneville prior to installation of the Measure; and

.3 in cases where a specific application is not addressed in the specification, codes, or regulations, the Utility shall determine the appropriate action consistent with the codes and these specifications. Utility decisions in these instances shall be thoroughly documented in the Residence file.

.020 The Utility reserves the right to add more restrictive requirements to the provisions contained in this specification and/or to require that additional provisions defined by the Utility be met under the Conservation and Renewable Resources Rate Discount Program.

101.030**Definitions**

For purposes of this specification, the following definitions apply. All other applicable definitions can be found in the main body of this Agreement.

.1 Permanent Housing. A Building containing Residence(s) which is either constructed on a site or transported to a site and is permanently located on that site designed never to be moved. It is not a Mobile Home.

.2 Code. The most recent edition of the Uniform Codes written by the International Conference of Building Officials (ICBO) including the Uniform Building Code (UBC), the Uniform Mechanical Code (UMC), Uniform Plumbing Code (UPC), Uniform Fire Code (UFC), and other associated codes and the National Electric Code (NEC) written by the National Fire Protection Association (NFPA) and associated codes.

102.000 **SPECIFICATIONS FOR DETERMINING ELIGIBLE MEASURES**

.005 The Utility shall be responsible for determining weatherization Measures eligible to be installed in each Residence per this specification.

103.000 **GENERAL REQUIREMENTS FOR UTILITIES**

.005 All weatherization shall be completed in a manner that will provide a safe, permanent, effective, and Workmanlike installation.

.010 Materials, components or products installed under this Program shall meet the criteria defined in the Material Provisions, Part II of this Item.

.015 Materials damaged in shipment or in assembly shall not be used.

.020 Structural members and Building components shall be free of decay and structurally sound before the weatherization Measure is installed.

.025 The Utility shall verify that the Installer has separately identified any unusual (but necessary) costs that affect the price in providing a safe, permanent, effective, and Workmanlike weatherization installation.

103.030 The Utility shall verify that the Installer has indicated in writing to the Homeowner or Homeowner Designee the types of materials to be used, brand names, methods of installation, identification of special problems, and other information which would minimize misunderstandings.

.035 Weatherization materials, products and labor shall be warranted by the Installer against failure due to manufacturing and installation defects for a period of at least 2 years, from the installation date, except that sealed, insulated-glass units shall be warranted against failure of the seal for a minimum of 5 years. The Installer shall provide a written warranty, with the installation date, to the Homeowner or Homeowner Designee. Manufacturers' written warranties may be used by Installers to satisfy a part of this requirement where appropriate.

.040 It is the Installer's responsibility to check clearances and access in attics and crawl spaces prior to job commitment, and to make appropriate allowances for ducts, joists, or other installation obstructions.

.045 The Installer is responsible for determining that the ceiling, floor, or wall systems are structurally adequate to support the combined weight of all materials imposed on the ceiling, floor, or wall. The Installer shall be responsible for damage incurred during or as a result of the installation of any materials and associated work.

.050 Installers shall provide permits, materials and labor necessary to install weatherization Measures in the Residence.

104.000 **INSULATION**

.010 Insulation shall be installed in areas of the Residence envelope that separate Conditioned Space and unconditioned or outside spaces where none exists or where the R-value is less than that prescribed in this specification.

.020 The Utility shall maintain a copy of an Installer certificate containing the following information where loose fill insulation is installed in ceilings, walls, or floors:

.1 address of the Residence;
.2 date of Installation;
.3 name and Address of Installer;
.4 the estimated R-value of any existing insulation;
.5 the amount, R-value, depth and type (including product name) of insulation installed by the Installer;
.6 final R-value of insulation; and
.7 area of the space (in square feet) insulated.

.030 Exhaust fans that terminate in attics, crawl spaces, or other spaces, shall be extended through to the outside and sealed to prevent any exhaust air from entering back into the space.

104.100 **Health and Safety Requirements**

.105 All insulation materials installed under this specification shall meet all applicable material requirements contained in the Material Provision.

.110 Insulation materials including facings (except foam plastic insulation--Specifications 104.115 and 104.120) shall be installed in accordance with installation requirements of the Uniform Building Code 1713(c). Flame spread and smoke developed limitations do not apply to facings, provided that the facing is installed in substantial contact with the unexposed surface of the ceiling, floor or wall finish.

.115 When foam plastic insulation is used, a thermal barrier having an index of 15 (UBC Standard No. 17-3) shall be present between the insulation and the interior of the Building.

.120 Foam plastic used in attics or crawl spaces shall be protected against ignition per UBC 1712(b)2.

.125 Recessed lighting fixtures and fan/light combinations that are Type-IC rated by UL may be covered with insulation. Fan/heater, fan/light/heater, and light/heater combinations may be covered with insulation IF they are rated "Heater" or "Air Heater."

.130 Ventilation fans may be covered with insulation IF all holes and penetrations are sealed with a nonflammable sealant.

.135 Only fluorescent fixtures with appropriate thermal protection shall be covered with insulation.

.140 Thermal insulation shall not be installed within 3 inches of fans, lights, and heaters that do not meet the requirements of 104.125 through 104.135 and other heat producing fixtures, and shall not be installed so as to entrap heat and prevent the free circulation of

air (NEC 410-66). Solid, flame resistant baffles attached to the ceiling structure shall be used to maintain required clearances.

.145 All combustible insulation materials, including existing insulation, shall be kept a minimum of 2 inches from metal flues and masonry chimneys. Noncombustible insulation may be installed with no clearance around flues and chimneys if permitted by local or State fire code. However, if the flue is a single wall type (i.e., made from a single thickness of rolled sheet metal) then, a 2-inch air clearance to all insulating materials shall be maintained. Noncombustible insulation is insulation material which conforms to the standard test method ASTM E-136-82.

.150 Knob-and-tube wiring shall be treated with special care. Insulation shall be installed such that free air circulation is maintained around all knob-and-tube wiring. (e.g., using tent baffles to maintain a 3-inch clearance, installing insulation under the wiring, etc.) Other methods as adopted at State or local code jurisdictions shall be submitted to the Utility and Bonneville for written approval prior to use. A more stringent local or State fire code may preclude using any one or all of these methods.

.155 Kitchen range exhaust fans vented through the ceiling shall be connected to a duct of not less than 30 gauge galvanized steel (UMC Chapters 10 and 11) which is substantially airtight throughout and which terminates directly to the outside in a vent cap. Backdraft dampers are recommended. Existing installations that substantially meet these requirements are acceptable.

.160 Kitchen range exhaust fans which are vented to the crawl space shall be ducted through to the exterior of the Building in accordance with local codes and the manufacturer's instructions.

.165 Only noncombustible insulation (per ASTM E-136-82) shall be installed in wall cavities adjoining fireplaces and/or chimneys.

.170 Insulation shall <u>not</u> be installed in wall cavities which contain electric space heaters unless fire stops are present which isolate the heater from all contact by the insulation material. Verification shall be accomplished by removal of the heater after the insulation is installed.

.175 Pipe insulation shall not be installed on pressure temperature relief valves, on the operating portion of any valves, or on any other control and safety devices.

.180 Where facings or protective coverings are used on pipe or duct insulation, these materials shall meet flame spread and smoke development requirements of the Codes.

.190 Where water pipe heaters are present for freeze protection, such heaters shall include a thermostat set at approximately 35 degrees Fahrenheit.

104.200 **Installation Provisions for Ceilings under Attic Space--Permanent Housing**

.205 Ceilings shall be insulated to a minimum of R-38 or the highest R-value approaching R-38 which is practical.

.210 Uninsulated sloped ceilings between ventilated attics shall be insulated where practical. Airflow may be maintained over the sloped-ceiling insulation by tubes, baffles, or by using rigid insulation; or the sloped-ceiling area may be insulated to the full cavity depth

where local codes allow, provided containment materials used at the lower and upper cavity openings allow for rapid vapor diffusion.

.215 Uninsulated knee walls adjoining attic spaces shall be insulated to the highest R-value which is practical or minimum of R-11, in accordance with Specification 104.1000 as part of attic insulation.

.220 All exposed ducts located in the attic space which will extend above the level of the finish attic insulation shall be insulated as specified in Specification 104.1400.

.225 Attic access doors which are adjacent to Conditioned Spaces shall be insulated to at least R-30 for horizontal openings and to at least R-11 for vertical openings and weatherstripped as per Specification 107.000.

.230 If water pipes are located in the attic space, water pipe insulation shall be included with ceiling insulation, for freeze protection as per Specification 104.1600.

.235 If vapor barriers are installed with ceiling insulation, the barrier shall be placed between the insulation material and the Conditioned Space adjacent to the ceiling.

104.240 **Ventilation Requirements**

Enclosed attics and enclosed rafter spaces shall have cross ventilation for each separate space. Ventilating openings shall be protected against the entrance of rain and snow.

.245 The net free-ventilating area shall be not less than 1/150 of the area of the space ventilated, except that the area may be 1/300, provided 50 to 60 percent of the required ventilating area is provided by ventilators located in the upper portion of the space to be ventilated at least three feet above eave or cornice vents with the balance of the ventilation provided by eave or cornice vents or provided a vapor barrier is present between the insulation and the ceiling.

.250 Other configurations of vent placement that provide equivalent performance may also be accepted with written Utility approval or as approved by local code.

.255 Vent openings shall be covered with corrosion-resistant metal mesh with mesh openings of maximum 1/4 inch in dimension.

.260 Air turbines shall not be installed under these specifications, however, ventilating area of existing air turbines may be included by estimating the net free ventilating area of the air turbine in a locked, nonrotating position.

.265 Utility may approve mechanical ventilation when passive ventilating methods are not practical.

104.300 **Installation Provisions for Roofs--Exterior Surface, Permanent Housing.**

.305 Roofs shall be insulated to a minimum of R-20 or the highest R-value approaching R-20 which is practical.

.310 Insulation shall not be applied to roofs over ventilated cavities. (e.g., vaulted ceilings with ventilated spaces, attics, sloped ceilings connected to attics and/or knee wall spaces, etc.) Ventilated cavities of flat or sloping roofs shall not be blocked.

.315 Insulation shall be in a rigid board form.

.320 A vapor barrier of 1.0 perm or less shall be in place between the insulation and the roof deck. However, if insulation is already present in the roof system, then a vapor barrier shall not be installed.

.325 Roof drainage systems shall function properly after insulation is installed (UBC 3207).

.330 Roof coverings shall be applied directly over the insulation per Section 3208 of the 1991 UBC.

.335 All penetrations through the roof covering and all joints between the roof covering and vertical surfaces (e.g., walls, chimneys, etc.) shall be flashed according to the requirements of the UBC 3208.

.340 The Installer shall contact the Utility and request an "in-progress" inspection by the Utility during the installation.

.345 Other methods of installing exterior roof insulation shall be approved by the Utility in writing prior to beginning the work.

104.400 **Installation Provisions for Roofs--Interior Surface, Permanent Housing**

.405 Roofs shall be insulated to a minimum of R-24 or the highest R-value approaching R-24 which is practical.

.410 Insulation shall be in a rigid board form.

.415 Lighting fixtures or similar items shall be extended to accommodate the lower ceiling level, at the Homeowner's or Homeowner Designee's expense.

.420 All air by-passes shall be sealed to minimize heat loss and moisture damage potential.

.425 Rigid board insulation shall be cut to fit, minimizing openings and gaps between beams that support the roof structure, other necessary protrusions (light fixtures, electrical boxes, etc.) and the insulation itself.

.430 Beam pockets and end-wall groves created by tongue-and-groove ceiling construction shall be sealed with caulk or with foam tape covered by trim board.

.435 Gaps between insulation boards and fixtures (e.g., ceiling lights, fans, etc.) when greater that 1/8 inch in width shall be filled with self expanding foam, chemically compatible with the insulation material. Gaps less than 1/8 inch in width shall be caulked.

.440 An in-progress inspection shall be requested by the Installer after the rigid board has been installed and prior to covering the insulation with a fire rated barrier to verify the insulation board is properly installed and sealed. The in-progress inspection shall be documented in the Residence permanent file.

.445 The fire-rated barrier shall be taped at all joints and sealed at all edges to ensure air/moisture infiltration paths have been eliminated.

.450 All associated costs (e.g. painting, taping, etc.) of the fire rated barrier (e.g., 5/8 inch sheet rock) and its installation are beyond the scope of the program and shall be covered by the Homeowner or Homeowner Designee.

104.600 **Installation Provisions for Underfloors--Permanent Housing**

.605 Underfloors shall be insulated to a minimum of R-30, or to the maximum level needed to fill the joist cavities..

.610 Any crawlspace access door adjacent to a Conditioned Space shall be insulated to at least R-19 for horizontal openings and to at least R-11 for vertical openings and shall be weatherstripped with appropriate materials.

.615 All exposed uninsulated ducts located in the crawlspace shall be insulated as specified in Specification 104.1400.

.620 Uninsulated walls separating the crawlspace from Conditioned Space shall be insulated to the highest R-value which is practical or minimum R-11 in accordance with Specification 104.1000.

.625 If water pipes are located in the crawlspace, water pipe insulation shall be included with underfloor insulation, for freeze protection, installed in accordance with Specification 104.1600.

.630 Water pipe heaters may be installed in localities which experience sustained periods of subfreezing temperatures during the winter. Such heaters shall include a thermostat set at approximately 35 degrees Fahrenheit, and they shall be placed around all water pipes (both hot and cold water) in the crawl space inside the pipe insulation in contact with pipe surface. Such installation shall conform to provisions of the National Electric Code and any applicable State or local code.

.635 Underfloor insulation support systems shall be installed so that the insulation remains in contact with the sub-floor, flat and in place for the life of the Residence. Support of the insulation may be provided by wood lath, twine, wire, or other material as approved by the Utility. If fiberboard sheathing is used to support insulation, then the sheathing shall have a water vapor permeability of 10 perms or more.

.640 Vapor barriers installed as a part of floor insulation shall have a perm rating of 1.0 or less and shall be located between the insulation material and the Conditioned Space.

.645 Upon completion of the installation of underfloor insulation, an acceptable ground-cover moisture barrier shall be present (new 6 mil black polyethylene or existing 4 mil polyethylene). All joints shall be overlapped with sufficient material so that all ground surface area is covered.

.650 If underfloor insulation is installed over an unheated basement and the basement has no exposed soil, then the provisions for a ground cover and ventilation are not required. Any basement with exposed soil shall be treated as a crawl space and the provisions for ventilation shall be required. In addition, a ground cover shall be present which covers the entire area of exposed soil.

.655 Underfloor insulation in areas which are exposed to environmental elements (wind, etc.) shall be protected after installation with a breathable cover or some type of perimeter system (e.g., skirts).

.660 Ground covers are not required for Residences which are built on stilts and have no perimeter system which creates a crawl space.

104.665 **Ventilation Requirements**

Underfloor crawlspace areas shall be ventilated by openings in exterior foundation walls. Such openings shall have a net area of not less than 1 square foot for each 150 square feet of underfloor area.

Where moisture due to climate and ground water conditions is not considered excessive, the Utility may allow operable louvers and may allow the required net area of vent opening to be reduced to 1/300 or less (minimum 1/1500), provided the underfloor ground surface area is covered with an approved ground cover.

Openings shall be located as close to corners as practical and shall provide cross ventilation. The required area of such openings shall be approximately equally distributed along the length of at least two opposite sides. They shall be covered with corrosion-resistant wire mesh with mesh openings of 1/4-inch in dimension. Existing vent openings which are covered with wire mesh need not be modified.

.670 Other configurations of vent placement that provide equivalent performance may also be accepted with written Utility approval or as approved by local code official.

.675 Contractors may approve mechanical ventilation when passive ventilating methods are not practical.

.680 If crawlspace ventilation cannot be accomplished in accordance with these requirements, underfloor insulation shall not be installed.

104.800 **Installation Provisions for Exterior Perimeters --Permanent Housing**

.805 Exterior perimeter insulation may be installed on Residences with basements, slab on grade floors or an existing whole-house plenum system.

.810 Insulation installed shall have a minimum thermal resistance of R-10 in exterior applications.

104.820 Slab, Crawlspace Plenum, or Basement Exterior Perimeter Insulation Installation Provisions:

.1 Insulation shall be installed from the bottom edge of the siding to a depth equal to the local "frost line" or 2 feet below grade, whichever is greater. In those areas that do not have freezing conditions or where the "frost line" is higher than 12 inches, the insulation shall extend a minimum of 12 inches below grade. Insulation shall not be installed below the level of the footing, but shall extend horizontally away from the footing for the remaining required distance. Under no circumstances shall excavation take place below the level of any foundation footing.

.2 Insulation shall be adhered to the foundation with an adhesive suitable for the purpose installed in continuous horizontal beads to block insect infestation.

.3 The exterior surfaces of the insulation material shall be water proofed with a suitable barrier and shall be protected from mechanical damage, solvents, mastics, moisture, and ultraviolet light degradation. Above grade, the insulation shall be covered with a suitable coating compatible with either adjacent walls or the previously exposed foundation surface in color and general surface appearance.

.4 Metal "Z" flashing shall be installed at the top edge of the insulation with the vertical flange extending up behind the siding to prevent water from getting behind the perimeter insulation.

.5 For exterior perimeter installation, only insulation board meeting the material requirement 204.030 shall be installed.

104.1000 **Installation Provisions for Unfinished Walls (Exposed Frame Wall, Concrete or Masonry Wall)--Permanent Housing**

.1005 Walls shall be insulated to a minimum of R-11.

.1010 Vapor barriers shall be installed when practical. Vapor barriers installed as part of wall insulation shall have a perm rating of 1.0 or less and shall be located between the insulation material and the Conditioned Space.

.1015 When rigid insulation is applied to the exterior stud surfaces of an open cavity frame wall, the insulation shall be installed tightly to minimize air leakage and an adequate air/vapor barrier shall be installed at the warm side of the insulation.

.1020 Upon completion of exterior surface retrofits, the exterior wall shall be weathertight with window and door jambs extended or modified to provide adequate drainage. Siding shall be installed per insulation or siding manufacturer instructions or as approved by the Utility.

.1030 See Specification 104.100 for flame spread and thermal barrier requirements of thermal insulation.

104.1300 **Installation Provisions for Exterior Wall Cavities--Permanent Housing**

.1305 Walls shall be insulated to minimum R-11 or the highest R-value that is practical.

.1310 Loose-fill insulation (fiberglass, rockwool, and cellulose) is acceptable for use in walls. Application of other materials shall be approved by the Utility and Homeowner or Homeowner Designee in writing prior to installation.

.1315 Insulation may be installed in wall cavities that are:

1) 3-1/2 inch deep or greater with no insulation or 1 inch or less of existing insulation; or
2) less than 3-1/2 inch deep with no existing insulation.

.1320 When blowing loose fill insulation, the insert tube method shall be used. Any other method of installation must be approved in writing by the Utility.

.1323 The manufacturer's instructions shall be followed when blowing wall cavities.

.1324 Access to the wall cavities may be accomplished by either removing pieces of the siding prior to drilling through the sheathing, or by drilling directly through the siding and the sheathing.

.1325 All wall cavities shall be filled from the exterior side unless approved in writing by the Utility and the Homeowner or Homeowner Designee.

.1330 The Utility shall verify the installation of insulation by inspection at electrical outlet or switch boxes, by in-progress inspection or other method as determined by the Utility. The Utility shall document to the Residence file the type of verification used.

.1335 The Utility shall check a minimum of three electrical wall outlets or switch boxes to ensure that any insulation material which may have entered the boxes during blow-in wall insulation application was removed by the Installer.

.1340 When access holes for installing the insulation are drilled through the finish siding and sheathing, the Utility shall verify that all holes were adequately plugged and provide a tight weatherproof seal.

104.1400 **Installation Provisions for HVAC Ducts--Permanent Housing**

.1405 HVAC ducts shall be insulated to a minimum R-11.

.1407 Ducts shall be properly supported before insulation is installed. All new and all accessible existing duct joints, plenum drives, metal joints to include all slips and drives shall be mechanically fastened with screws. Flexible ducts shall be attached using nylon/plastic straps tightened with a manufacturer approved tool (hand tightening is not acceptable) or stainless steel worm drive clamps. Mastic and/or tape shall not be used as mechanical fasteners.

.1410 All new and all accessible existing HVAC supply and return ducts, air handlers, and plenums inside and outside the heated space shall be sealed at all joints and corners, including prefabricated joints, with duct mastic. It is unnecessary to seal longitudinal seams unless they are damaged. Tape is not allowed except for use on operable doors in the system such as on the air handler. In this case, foil tape with a 15-mil butyl sealant, or cleaning the joint with a suitable solvent and sealing with a UL-181 listed tape may be used.

.1415 Special care shall be taken when insulating flex duct so that the duct wall does not collapse.

.1420 Ducts subject to human contact during service or storage activities (e.g., in garages, basements, attics used for storage) shall be insulated with a material that has a suitable facing as defined in Specification 204.040 (flame spread requirement).

.1425 The entire system including plenums and boots shall be sealed and insulated. All duct insulation should be installed and supported using mechanical fasteners such as permanent plastic straps or nylon twine. Tape is not a mechanical fastener. Tape may be used at insulation seams to provide a continuous barrier.

.1430 Ducts which carry chilled air (any type of heating and air conditioning system) shall be completely insulated with a material that has a facing with the proper flame spread rating as defined in Specification 204.040.

104.1600 **Installation Provisions for Hydronic and Water Pipe Insulation-- Permanent Housing**

.1605 Pipe insulation shall be installed to minimum R-values determined according to the following:

Hydronic pipes having a nominal diameter of 1-inch or less shall be insulated with material having a minimum R-value of 3.6 tested in accordance with ASTM C-177-85 at a mean temperature of 75 degrees Fahrenheit. Pipes with a nominal diameter greater than 1 inch shall be insulated with material having a minimum R-value of 5.4 tested in accordance to ASTM C-177-85 at a mean temperature of 75 degrees Fahrenheit.

Water pipes shall be insulated with material having a minimum R-value of 3.0 tested in accordance with ASTM C-177-85 at a mean temperature of 75 degrees Fahrenheit.

.1610 The piping shall be free from water leaks and properly secured to support the weight of the piping and insulation.

.1615 The product may be either flat and capable of being molded to the outside surface of common pipe sizes, or preformed to fit standard pipe diameters. If the product is preformed, dimensions shall be specified by the Utility and be appropriate for the pipe size intended to be insulated.

.1620 Pipe insulation shall be installed on piping, joints, elbows, valve bodies, etc. except those sections of the system which are obstructed by existing wood framing members or other Residence components. Insulation material shall be cut and folded or otherwise molded to completely cover all sections of the system without compressing the insulation or allowing gaps to occur in the insulation.

.1625 Insulation shall be firmly secured to the piping system using adhesive, tape, or plastic or galvanized wire ties.

.1630 All slits and joints in the material shall be sealed on hydronic heating system pipes.

.1635 If insulation is installed on piping exposed to the weather, then such insulation shall be resistant to degradation from moisture, ultra-violet light, and extremes in temperature, or a jacket or facing shall be installed that protects the insulation from these conditions. Manufacturer's recommendation for outdoor installations shall be followed in all cases.

105.000 **WINDOWS**

.005 Storm windows, vent conversions and fin-bar conversions are not acceptable under this program. New prime windows and patio doors (French or Sliding) that are Energy Star labeled for the Northern Climate Zone may replace existing dual-glazed windows in non-wood or vinyl framed windows or single-glazed windows regardless of frame type.

105.400 **General Installation Provisions**

.405 Window frames shall be permanently affixed to the Residence. After installation, access to latches shall not be impaired. Upon installation completion, units shall operate smoothly and properly. Hardware shall be durable, function properly, and not create interference. When closed, the entire assembly shall provide a complete weather-barrier

to the entire opening. Glazing sealants shall be resilient, non-hardening compounds, tapes, or gaskets with established long life expectancy.

.410 The correct size, shape, and type of windows for the openings shall be assured by the Installer. Each window shall be Measured for appropriate clearances and "out-of-squareness" to match the prime window or prime opening. The window may need to be adjusted to be square, plumb, and level without distortion to the window parts, upon installation.

.420 Any installation that results in increased window area, including garden windows, shall not be allowed under this Program.

.435 No windows shall have exposed burrs, sharp corners or other potential hazardous condition that could be encountered by occupants during normal use.

.440 Sources of evident water penetration through prime openings shall be located and corrected. Necessary repairs shall be accomplished by the Homeowner or Homeowner Designee prior to installation of storm windows.

105.500 **Health and Safety Requirements**

.505 Safety glass shall be used under the following conditions:

.1 Glazing in entrance doors;

.2 glazing in fixed and sliding panels of sliding doors and panels in swinging doors other than wardrobe doors;

.3 glazing in fixed or operable panels adjacent to a door where the nearest exposed edge of the glazing is within a 24-inch arc of the vertical edge of the door in a closed position and where the bottom edge of the glazing is less than 60-inches above the floor or walking surface unless there is an intervening wall or permanent barrier between the door and the glazing;

.4 glazing in an individual fixed or operable panel other than those covered by 105.505.3 above that meet ALL of the following conditions:

a. have an exposed area of an individual pane greater than 9 square feet;
b. has an exposed bottom edge less than 18 inches above the floor;
c. has an exposed top edge greater than 36 inches above the floor; and,
d. has one or more walking surfaces within 36 inches horizontally of the plane of the glazing.

In lieu of safety glazing, such glazed panels may have a protective bar installed on the accessible sides of the glazing 34 to 38 inches above the floor. The bar shall be capable of withstanding a horizontal load of 50 pounds per linear foot without contacting the glass and be a minimum of 1 1/2 inches in height.

.5 Glazing in any portion of a building wall enclosing showers, hot tubs, whirlpools, saunas, steam rooms, and bathtubs where the bottom exposed edge is less than 5 feet above a standing surface or drain inlet.

Each pane of safety glass lite shall be marked with the name of the manufacturer and place of manufacture, and shall certify compliance with all applicable standards for the manufacture and testing of safety glass (e.g., CPSC Class 2).

.515 Retrofitted. vertically-opening prime windows shall not free fall.

105.900 **Additional Installation Provisions for Replacement of Prime Windows -- Permanent Housing**

.910 Multi-glazed windows may replace single-pane glazing in entrance doors located between Conditioned Space and unconditioned space.

.915 Installation procedures employed shall ensure that the integrity of the multi-glazed seal is maintained.

.920 A sealed, insulating-glass panel shall be separated from the perimeter of any metal retaining frame by an elastomeric thermal barrier (e.g., channel glazing). If sealed glazing is not used, individual panes of glass shall be separated from any metal retaining frame, and from any adjacent panes of glass, by an elastomeric thermal barrier.

.925 Glazing compounds shall not contact the seal of the multi-glazed unit or the material shall be shown to be chemically compatible with the seal of the multi-glazed unit.

106.000 **DOORS**

.005 This section covers the requirements for the construction and installation of sliding multi-glazed inserts, sliding door replacements with new multi-glazed units, and French doors. French doors with sealed, insulating glass may replace existing single-glazed french doors or existing single-glazed sliding doors. New prime patio doors (French or Sliding) that are Energy Star labeled for the Northern Climate Zone may replace existing dual-glazed windows in non-wood or vinyl framed windows or single-glazed windows regardless of frame type.

.010 The installation of storm doors and insulated entrance doors are not allowed under the Program.

.015 The installation of storm doors over sliding glass doors are not allowed under this Program.

.020 The installation of fin-bar conversions in sliding glass doors is not allowed under this program.

106.100 **Installation Provisions for Sliding and French Doors--Permanent Housing**

.105 Sliding- and French-door retrofit Measures shall be installed so that a durable, effective, infiltration barrier is provided.

.110 Gaps and cracks exposed to the elements shall be caulked on both existing and added framing members so as to provide a weathertight installation.

.115 Worn or damaged weatherstripping or sealants on the prime assembly shall be replaced when the door is weatherized. This includes replacement of the meeting rail weatherstripping. All materials used shall be compatible to the manufacturer's slide system and be a permanent repair or replacement.

107.000 INSTALLATION PROVISIONS FOR AIR SEALING

107.100 Prescriptive Air Sealing

.105 All gaps, holes, joints and seams in HVAC ducts and plenums shall be sealed. This includes sealing all joints from the furnace to the plenum, the plenum to the main duct, the boots for each register to the main duct, the boots for each register to the floor. Seal all branch-duct to main-duct connections when necessary.

.110 All gaps and holes where HVAC ducts, plenums and registers penetrate the envelope shall be sealed.

.115 All gaps between exhaust-fan ducts and the envelope, including those for kitchen ranges, bathrooms and clothes dryers, shall be sealed. All missing or deteriorated backdraft dampers shall be replaced.

.120 All gaps between the ceiling for swamp cooler ducts shall be sealed.

.125 All electrical penetrations, including the electrical service panel shall be sealed.

.130 All air bypasses in electrical/plumbing chases and around chimneys, flues, etc., except for single-wall metal flues, that penetrate floors and ceilings shall be sealed with 5/8-inch, Type-X sheet rock.

109.000 CLOCK THERMOSTATS

.005 Clock thermostats may be installed when determined to be appropriate by the Utility.

109.100 Installation Provisions

.105 Clock thermostats shall be installed in compliance with local codes and the manufacturer's instructions.

.110 The Installer shall provide written instruction materials to the Homeowner or Homeowner Designee. The Installer shall also explain the clock thermostat's operation and method of adjustment to one or more members of the Residence.

PART II--MATERIAL PROVISIONS

Index to Sections

202.000 GENERAL MATERIAL PROVISIONS

.005 Materials, components or products installed under the Conservation and Renewable Resources Rate Discount Program (C&R Discount Program) shall meet the criteria defined is this specification. Materials, components or products for which the Utility or Bonneville has the opportunity to accept under the specification shall be submitted to the Utility or Bonneville for evaluation and written acceptance prior to their installation. Product evaluation shall be based on test results from a mutually acceptable independent laboratory indicating compliance to the requirements contained in this specification.

.010 The Utility or Bonneville reserves the right to identify and disapprove for use in the C&R Discount Program, any weatherization product at any time when it deems the product not satisfactory for the C&R Discount Program.

.015 Where written acceptance of materials, components, or products is required, the intent is that, unless otherwise stated in the specification or the acceptance, once it is accepted by a Utility or Bonneville for one installation, the material, component, or product shall be acceptable for all other similar installations without resubmittal to the Utility or Bonneville except as noted in Specification 202.010 above.

.020 The Utility may decide that a product or its installation is unsatisfactory after an inspection is performed even if that product has been accepted previously by the Utility or Bonneville. A rejection based on the installation may require the Installer to correct the work done. Also, the Utility has the right to disapprove the use of the product on all future jobs. Such disapproval shall be issued in writing and shall identify the flaws found in the product or its installation. The Utility shall notify Bonneville of any products which are disapproved.

.025 All materials used under the C&R Discount Program shall be resistant to corrosion, degradation from ultraviolet light, and be compatible with other elements and materials

(will not react chemically, etc.) so as to enhance long life expectancy of installed Measures.

204.000**INSULATION MATERIAL PROVISIONS**

.005 The American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Handbook of Fundamentals (1989 or later) is the accepted standard for R-value/U-value of materials used by Installers. Products that vary from ASHRAE may be acceptable if they comply with current Federal Trade Commission (FTC) certifications, testing and labeling rules, and have independent laboratory testing which indicates the product's R–value/U-value.

.010 All materials used for thermal insulation shall meet the requirements of UBC 1713 and UBC 1712 and meet the requirements contained in the applicable Federal specifications listed below. Certain requirements in these specifications refer to voluntary standards such as ASTM for specific test methods or physical properties. For purposes of compliance with this weatherization specification, the referenced voluntary standard shall be considered as mandatory.

.1	Mineral Fiber Blankets/Batts	HH-I-521F
.2	Mineral Fiber Loose Fill	HH-I-1030B
.3	Cellulose Loose Fill	ASTM C-739-86 16 CFR 1209 16 CFR 1404
.4	Perlite	ASTM C-549-81
.5	Vermiculite	ASTM C-516-80
.6	Polystyrene Board	ASTM C-578-87A
.7	Polyurethane and Polyisocyanurate Board	HH-I-530B

.015 In addition, loose-fill cellulose manufacturers shall subscribe to an ongoing laboratory quality control inspection Program substantially equivalent to the "UL classification" Program. This Program verifies periodically manufacturer's adherence to the requirements of CPSC cellulose regulation 16 CFR 1209 (i.e., critical radiant flux, smoldering combustion, settled density, and corrosiveness). Also, the UL label or equivalent label shall appear on every bag of material. It shall include the file number (R-number) of the manufacturer and the issue number for labels purchased.

204.020 All insulation materials installed shall meet the requirements of the Federal Trade Commission Labeling Rule (16 CFR 460). Additional labeling on weatherization materials may be required under the RCS regulations for covered utilities.

.025 Urea-Formaldehyde foam insulation is not acceptable.

.030 Insulation board which is used for perimeter insulation shall have a moisture absorption rate no greater than 0.3 percent when tested in accordance with ASTM C-272-53 and a water vapor transmission rate no greater then 2.0 Perm/inch of thickness when tested in accordance with ASTM E-96-80. Expanded polystyrene (bead board) is not acceptable.

.035 Duct insulation for use in unconditioned areas on ducts not subject to routine human contact shall meet the requirements of Federal Specification HH-I-521F, any type. For ducts subject to routine human contact during servicing or storage activities, (e.g., in garages, basements, attics used for storage) the insulation shall meet HH-I-521F and either be classified as Type 2 or 3, Class A (reflective or non-reflective, flame rated, faced batts) material. Faced material shall have a covering which provides physical protection to the insulation and has a flame spread of 50 or less when tested in accordance with ASTM E-84-88 when used on duct systems which serve single Residences only. In Buildings having a duct system which serves more than one Residence, the covering shall have a flame spread of 25 or less when tested in accordance with ASTM E-84-8O.

.040 Pipe insulation shall meet the following provisions:

.1 Pipe insulation materials shall be comprised of mineral fiber, elastomers, urethanes, isocyanurates, or other suitable materials;

.2 the material shall be capable of withstanding continuous operating temperatures of not less than 180 degrees Fahrenheit. Hydronic pipe insulation shall be capable of continuous operation at 250 degrees Fahrenheit;

.3 The product shall be finished with a jacket or facing, suitable to resist damage and degradation. However, if the product is made of closed cell foam and is installed in a location protected from moisture, ultraviolet light and extremes in temperature, then a protective jacket or facing is not required; and

.4 the insulation material, any jackets or facings, and adhesive, if used, shall be tested as a composite product and shall have a flame spread rating of 25 or less, and a smoke density of 50 or less when tested in accordance with ASTM E-84-88.

205.000 **WINDOW MATERIAL PROVISIONS**

.005 Laboratory tests required to satisfy any of the preceding provisions shall be conducted no less frequently than every 4 years.

.015 All materials shall have sufficient strength and durability to resist damage or distortion from wind loads, thermal stress (including that due to solar gain), or induced installation stresses. All operable windows shall be of sufficient combinations of glass/slider- frame rigidity to prevent bowing after installation.

.020 Glazing for windows is restricted to glass or as provided for in this specification. All lites shall be of good quality glazing materials, and shall meet Federal Quality Control Specifications ASTM C1036-85 and ASTM C1048-88.

.030 Meeting rails of movable windows shall be provided with a durable, effective, infiltration barrier and shall include a mechanical interlock or equivalent mechanism. All sliding panes or associated channels shall be fitted with infiltration and weather barrier devices.

.035 Vertical moving windows shall be designed to hold the sash secure and level in ventilating positions.

.040 Security latches are required on all prime window replacements.

.045 Weatherstripping material used in windows shall be appropriate to the window type and its operation and shall provide a durable effective seal.

.050 Each safety glass lite shall be marked with the name of the manufacturer and place of manufacture, and shall certify compliance with all applicable standards for the manufacture and testing of safety glass (e.g., CPSC Class 2).

.055 Replacement Sealed Insulating Glass Units (Glazing Only):

.1 Shall be wood stopped, have a minimum air space of 1/2 inch, have one low-e coating with an emissivity of 0.2 or less and meet the requirements of 205.075.2 (e.g., site built picture type windows).

.2 Shall incorporate sealed, insulating glass, certified as "Class A" under a SIGMA-approved Program, which requires compliance with ASTM E 774-88. Manufacturer identification of certified panels shall be stamped, engraved, or inked on the spacer which separates the panes of glass, etched on the glass itself, or printed on a label located between the panes of glass and affixed to the glass. Such identification indicates the certifying agency (e.g., ALI or IGCC) and the performance class or classes of the unit.

.060 Replacement Prime Windows (Glazing, Sash, and Frame):

.1 Prime replacement windows shall meet the Energy Star specifications for the Northern Climate Zone and shall be NFRC labeled and certified to have a maximum U-factor of 0.35.

206.000 **SLIDING AND FRENCH DOOR MATERIAL PROVISIONS**

.005 Door products shall meet the Energy Star specifications for the Northern Climate Zone and shall be NFRC labeled and certified to have a maximum U-factor of 0.35.

206.010 Sealed insulating glass panels installed in door assemblies:

.1 shall have a minimum spacing of 1/2 inch, have one low-e coating with an emissivity of 0.2 or less when installed in a frame on the job site, and

.2 shall be certified as "Class A" under a SIGMA-approved Program. This certification means the manufacturer is participating in a continuing quality assurance Program which requires compliance with ASTM E-774-88. Manufacturer identification of certified panels shall be stamped, engraved, or inked on the inside of the spacer which separates the panes of glass, etched on the glass itself, or printed on a label located between the panes of glass and affixed to the glass. Such identification indicates the certifying agency (e.g. ALI or IGCC) and the performance class or classes of the unit.

.015 Glazing shall be restricted to safety glass. The thickness, strength, and quality of glass and glazing shall meet with the requirements of Chapter 54 of the Uniform Building Code. All lites shall be of distortion-free, good quality glazing, and shall meet ASTM C1036-85 and ASTM C1048-88.

.020 Screens shall be provided with all complete door assembly replacements.

207.000 **WEATHERSTRIPPING MATERIAL PROVISIONS**

.005 Products used in the Program shall be designed to resist deterioration when subjected to sunlight, moisture, other weather conditions, and normal use.

.010 Weatherstripping shall be of the following types:

.1 Hollow, cold weather, vinyl tube type or vinyl-silicone composite material which is affixed to a prepunched aluminum flange or extrusion;

.2 spring metal cushion weatherstrip;

.3 cold weather vinyl type or vinyl-silicone composite material which is affixed to a prepunched aluminum flange or extrusion;

.4 interlocking metal weatherstrip;

.5 two-piece, magnetic bellows-type weatherstrip;

.6 vinyl bulb or vinyl-silicone composite material with a semirigid flange; or

.7 polypropylene replacement pile.

Other types of weatherstripping material shall be submitted to the Utility for examination and written Bonneville approval prior to use.

208.000 **CAULKING MATERIALS PROVISIONS**

.005 Caulking shall be one of the following materials conforming to the Federal Specifications listed below or material demonstrating equivalent performance in resiliency and durability:

.1	Silicone Rubber	TT-S-1543A
.2	Polysulfide or Polyurethane (single component)	TT-S-230C
.3	Polysulfide or Polyurethane (multiple component)	TT-S-227E
.4	Acrylic Terpolymer (single component)	TT-S-230C
.5	Butyl Rubber	TT-S-1657
.6	Acrylic Latex	ASTM C834-76

.010 The cartridge or tube containing the caulking material shall be labeled indicating conformance to the applicable Federal Specification.

209.000 **CLOCK THERMOSTAT MATERIAL PROVISIONS**

.005 The clock thermostat ("low-voltage" and "line voltage" types) shall meet the requirements of NEMA DC 3-1984.

.010 The clock thermostat shall be easily Programmable by the Homeowner or Homeowner Designee and shall be at least a 24-hour type. Seven day clocks are preferred. In addition, the thermostat shall allow for at least two separate setback periods per day (i.e., day as well as night setback). Where central air conditioning (or a heat pump) is present, the thermostat shall allow for summer "setup" as well as winter "setback" control.

.015 The clock thermostat shall have independent adjustment capability for the "high" and "low" temperature set points.

.020 Thermostats used with heat pumps shall be capable of restricting the use of electric resistance elements during the normal temperature pickup periods. Such thermostats shall be designed so that the temperature pick up is accomplished by using heat pumping as much as possible and electric resistance elements only when necessary. This may be accomplished either by inhibiting electric resistance elements or by applying an electronic control technique which allows for the operation of electric resistance elements only when the heat pump will be unable to attain the setpoint within a suitable recovery time. The Utility or Bonneville shall approve each heat pump thermostat model, in writing, prior to installation.

.025 Line voltage clock thermostats shall be tested and meet minimum performance requirements of Canadian Standards Association C273.4-M1978 or other equivalent test procedures and standards.

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Conservation and Renewables Discount Program Specification Changes for FY2005

Appendix T

Section	Summary	New Spec	Old Spec
No changes were made to these specifications			

Appendix T

Field Verification Protocol for Determining Reduction in Infiltration Levels and Mechanical Ventilation Requirements for Site Built and Mobile Homes with Verified Air Sealing

October 1, 2001

Scope: This Appendix describes the blower door test protocol for testing the air-leakage of site built single family houses and manufactured/mobile homes to determine the reduction in air infiltration level achieved by air sealing measures. It also sets out the minimum mechanical ventilation system requirements that must be met whenever house tightening measures are installed.

1.0 TESTING PROTOCOL

1.1 When to Test:

1.1.1 New construction -

Testing shall occur after everything is roughed-in/ installed that will penetrate the building envelope (e.g., plumbing, electrical, HVAC, ventilation, combustion appliances, etc.) and the air barrier has been installed.

1.1.2 Existing construction -

Testing shall occur immediately prior to the installation of any air leakage control measures. Post-installation testing shall occur immediately following the installation of air leakage control measures.

1.1.3 Test conditions -

Testing shall not be done when the outside wind speed exceeds 15-20 miles per hour.

1.2 House/Residence Preparation:

All single family houses and manufactured/mobile homes shall be checked before testing to assure that following preparation measures have been completed.

1.2.1 Building envelope:

All windows and doors shall be properly closed, including pass-through wood-box doors and pet doors. All interior doors shall be left open.

1.2.2 Ventilation openings:

All exhaust fan openings, vent openings, and intake-air vents with backdraft dampers (e.g., dryer vents and kitchen, bathroom, utility room, whole-house, range vents, etc.) shall NOT be sealed.

Exterior vent openings without backdraft dampers (e.g., some continuous ventilation systems) shall be temporarily sealed for the test. Heat recovery ventilator supply openings shall be sealed. Heat recovery ventilator exhaust openings should have backdraft dampers and shall not be sealed.

1.2.3 Forced-air heating systems:

Supply and return registers shall NOT be sealed and the heating system shall be turned off. HVAC ducts shall be tested with the envelope. Dampers in the outside-air supply duct into the return plenum shall be closed.

1.2.4 Combustion appliances:

All flue dampers, fireplace doors, and wood burning stove doors shall be closed, but NOT sealed.

1.3 Equipment Set-up:

The blower door equipment shall be set-up using the following procedure:

1.3.1 Gauge temperature

Keep the gauges at room temperature if possible. Cold temperatures may affect gauge accuracy.

1.3.2. Blower door

Install the blower-door assembly according to manufacturer's instructions.

1.3.3. Set up the gauge assembly with the gauges plumb and level. This procedure is not required for digital guages.

1.3.4. Attach a hose to the indoor pressure tap. Place the free end of the hose indoors away from the fan airflow path at the approximate height of the fan centerline. If using a digital gauge, run a hose outside through the blower door shroud; make sure the end of the hose is not in the air stream of the blower door. Use of a static pressure tap is recommended.

1.3.5. Exercise the gauges by blowing and sucking on the hoses to drive the gauges over their entire range six to eight times. Install the fan orifice plate, plug or seal all holes, and adjust the gauges to zero. This procedure is not required for digital guages.

1.3.6. Start the fan and depressurize the house to check for anomalies in the building envelope.

1.4 Performing the Test: Perform the test using the following procedures:

1.4.1. Depressurize the house to 55 Pascals and reduce the pressure to 50 Pascals (0.205 inches of water).

1.4.2. Tap the gauge to reduce stored spring energy from the gauge needle and wait for the needle to stabilize before recording the readings. This procedure is not required for digital guages.

1.4.3 View the gauge from directly in front when taking a reading. Maintain a consistent line of sight to avoid parallel errors or distortions from the gauge cover. This procedure is not required for digital guages.

1.4.4. Increase the pressure again and then retest at 50 Pascals.

1.5 Computing Air Leakage Reduction:

1.5.1 Calculate the ACH @ 50 Pascals (ACH50pre) prior to installation of air sealing measures and divide this value by 20 to estimate the average annual infiltration rate (ACHavg).

1.5.2 Calculate the ACH @ 50 Pascals (ACH50post) after installation of air sealing measures and divide this value by 20 to estimate the average annual infiltration rate (ACHavg).

1.5.3 Subtract the value obtained in step 5.2 from that obtained in step 5.1 to determine the reduction in annual infiltration rate achieved. Round this value to the nearest 0.1 ACH.

1.6 Estimate Annual Energy Savings and C&R Discount Credit:

1.6.1 To compute the annual energy savings multiply the estimated reduction in annual infiltration rate times the homes floor area times the value in Table 1 for the appropriate building type and climate zone.

Table 1 - Annual Energy Savings (kWh/sq.ft./0.1 ACH change)			
Building Type	Zone 1	Zone 2	Zone 3
Mobile/Manufactured Homes	0.62	0.80	0.94
Site Built Homes	0.2	0.32	0.37

1.6.2 To compute the C&R Discount Credit multiply the estimated annual energy savings obtained in Step 6.1 times the value in Table 2 for the appropriate building type and climate zone.

Table 2 - Conservation and Renewable Rate Discount Credit ($/kWh saved)			
Building Type	Zone 1	Zone 2	Zone 3
Mobile/Manufactured Homes	$ 0.39	$ 0.39	$ 0.39
Site Built Homes	$ 0.50	$ 0.50	$ 0.50

2.0 - MECHANICAL VENTILATION REQUIREMENTS

2.1 Mechanical Ventilation

A mechanical ventilation system meeting either the requirements of 2.1.1, 2.2, 2.3 or 2.4 shall be installed in all homes that have reductions in air leakage rates verified through this protocol.

2.1.1 Non-Heat-Recovery Ventilation - Intermittent Operation

2.1.1.1 A bathroom exhaust fan is controlled by both a manual switch, crank timer or dehumidistat in the bathroom to provide spot ventilation AND a time clock to provide whole-house ventilation when called for by the timer. Outside-air inlets in all living areas and bedrooms, and undercut doors, grilles, transoms,

or other approved means provide fresh-air circulation through the house to the bath fan.

2.1.1.2 Exhaust ducts shall be smooth metal and terminate outside the house at the closest possible location. All connections shall be tight fitting and taped or sealed, and backdraft dampers shall be provided.

2.1.1.3 The minimum exhaust airflow rates shall comply with either the performance OR prescriptive paths listed below. Surface-mounted fans shall have a sone rating of 1.5 or less, or other rating as approved by the Utility. Existing fans that meet the minimum airflow rates are exempt from the sone rating requirement.

2.1.1.3.1. **Performance Path:** The minimum measured airflow capacity shall be either 0.35 air-changes per hour (ACH) or those listed below:

Number of Bedrooms		Measured Exhaust Flow
1		45 cfm
2		60 cfm
3		75 cfm
4		90 cfm

To calculate the ACH for a fan with a MEASURED airflow of 45cfm multiply by 60 to obtain the airflow per hour (45 X 60 = 2700 cfh) and divide by the volume of the heated space.

2.1.1.3.2 **Prescriptive Path:** Ventilation systems that do not meet the performance path shall provide 0.35 ACH based upon the rated fan flow minus 15 cfm or use the rated fan flows in the following table:

Number of Bedrooms		Rated Fan Flow
1		70 cfm
2		85 cfm
3		100 cfm
4		115 cfm

To calculate ACH based on the RATED airflow, subtract 15 cfm, multiply by 60, and divide by the volume of the heated space.

2.1.1.4 The fan shall have both automatic and manual controls. Automatic controls shall include a time clock or cycle timers with a minimum of 2 on-periods per day, a manual control switch to lot the occupant turn the fan on or off, and be set to operate a minimum of 8 hours per day.

2.1.1.5 The ventilation fan shall be wired to both the manual spot-ventilation switch in the bathroom and to a time clock.

2.1.1.6 Individual outside-air inlets, located to avoid drafts, shall provide a minimum of 4 sq. inches per bedroom and combined living area.

If a whole house blower door test, in accordance with Appendix T and conducted after air sealing measures are installed, results in an $ACH_{50} \div 20$ greater than 0.35 and the house has no combustion appliances capable of backdrafting (i.e. naturally vented or atmospheric chimneys) within the exterior shell of the house, the outside-air inlets may be omitted.

2.1.1.7 The outside-air source shall be located at least 3 feet from exhaust vents and to minimize drawing outdoor pollutants and excessive outdoor noise inside during operation.

2.1.1.8 The outside-air source shall limit excessive airflows during normal operation and have a weather protection hood and maximum 1/4" screen-mesh, or as approved.

2.2 Unbalanced Non-Heat-Recovery Ventilation-Continuous Operation

2.2.1 This system uses a continuously-operating fan to exhaust air at a minimum rate of 25 cfm for the kitchen, and 20 cfm for each bathroom, with a maximum rate of 0.5 ACH. One fan exhausting from the kitchen and each bathroom also provides spot ventilation. An integrated spot and whole-house fan is acceptable if spot ventilation is also provided for the kitchen and for the bathrooms.

2.2.2 The exhaust-air pickup in the kitchen shall not be over the kitchen range.

2.2.3 If the exhaust flow from each kitchen and bathroom is not measured, the rated fan capacity shall exceed the required flow rate by a minimum of 15 cfm.

2.2.4 The continuous ventilation fan(s) shall be wired to an existing circuit or to the electrical service panel.

2.2.5 The outside-air inlet and source requirements shall be the same as Sections 2.1.1.6, 2.1.1.7 and 2.1.1.8.

2.3 Balanced Flow Non-Heat Recovery Ventilation-Continuous Operation

2.3.1 Balanced flow non-heat-recovery air exchange units shall:

2.3.1.1 have fans capable of providing the intake and exhaust airflow rates in section 2.1.1.3 at 0-25 inches of water gauge as determined by HVI 916 (July 1993);

2.3.1.2 provide complete isolation of the intake and exhaust air;

2.3.1.3 have UL approval of all electrical components;

2.3.1.4 have outside-air inlets in all living areas and bedrooms, positioned so-as-to avoid drafts; and

2.3.1.5 be installed according to the manufacturers instructions.

2.4 Air-to-Air Heat Exchangers

2.4.1 Air-to-air heat exchangers shall:

2.4.1.1 Provide the ventilation rates in Section 2.1.1.3;
2.4.1.2 have a minimum sensible heat recovery efficiency of 65 percent at 117 cfm and 32°F for homes larger than 1300 ft.2 and 55 percent at 64 cfm and 32°F for houses of 1300 ft2 or less as certified by the Home Ventilation Institute (HVI);
2.4.1.3 have a filter on the upstream side of the heat exchanger in both the intake and exhaust airstreams;
2.4.1.4 provide protection against ice buildup that does not disable the unit during freezing weather; and
2.4.1.5. be installed according to manufacturer's instructions.

2.5 Other Mechanical Ventilation Systems

2.5.1 Other mechanical ventilation systems meeting the Site Built or Manufactured Housing Super Good Cents specifications may be used if approved by Bonneville.

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Conservation and Renewables Discount Program
Specification Changes for FY2005

Bright Way Solar Water Heater General and Technical Specifications

Section	Summary	New Spec	Old Spec
No changes were made to these specifications			

GENERAL AND TECHNICAL SPECIFICATIONS

1. GENERAL PROGRAM SPECIFICATIONS

1.1. The solar water heater (SWH) must be installed at a residence with electric service provided by the Utility.

1.2. The participating customer must be the owner of the property or the owner's legally assigned representative.

1.3. To qualify for Bonneville incentive, service hot water to the property must be supplied by an electric water heater.

1.4. Only solar water heaters determined eligible by Bonneville qualify for the Program. Owner-built systems and additions to existing systems do not qualify.

1.5. The eligible solar water heater must be purchased from a contractor determined eligible by the Utility to participate in the program.

1.6. The installed SWH shall be inspected by a Utility representative to determine compliance with all program requirements.

2. GENERAL EQUIPMENT SPECIFICATIONS

2.1. Systems must undergo a technical review by Bonneville to be determined eligible for the Program. Desired design life for the system is 20 years.

2.2. All solar collectors must have OG-100 certification by the Solar Rating and Certification Corporation (SRCC). All solar water heating systems must have SRCC OG-300 certification.

2.3. Eligible solar water heating systems shall incorporate freeze and over heat protection strategies that:

a. Require no regular manual operations on the part of the residence occupant,
b. Result in no lost electrical energy due to re-circulation of heated water during cold winter conditions,
c. Result in no lost electrical energy due to drain of heated water, and
d. Possess demonstrated or theoretical reliability in weather conditions common to climates of the Pacific Northwest.

Developed by Eugene Water & Electric Board

Revised May 2003

2.4. Equipment and installation shall comply with all applicable building and electrical codes, and building permits shall be required for all installations where applicable.

2.5. Equipment, materials, and installation shall comply with manufacturers' specifications, SRCC Document OG-300, Operating Guidelines and Minimum Standards for Certifying Solar Water Heating Systems, the specifications included in this document, and any others required by Bonneville or the Utility. Bonneville reserves the right to require compliance with installation specifications that may exceed or differ from those of a manufacturer and/or SRCC.

3. INSTALLATION SPECIFICATIONS

A. Consumer Documents

1. *Customer has received contractor's installation and manufacturer's component warranties.*

   Contractor shall provide customer with a written warranty stating the equipment and installation will be free from all defects in workmanship and materials for at least two years from the date of final approval by the Utility. Warranty shall include all labor for any repairs within the warranty period. Manufacturer's component and material warranties shall be supplied to customer and may be used to satisfy part of this warranty requirement.

2. *Customer has received an owner's manual and complete operating instructions*.

   Contractor shall provide customer with a comprehensive owner's manual for the system, including detailed operation and maintenance instructions to help ensure effective and persistent system operation.

3. *If SRCC OG-300 certified system, OG-300 sticker is attached to front of owner's manual, and OG-300 label is attached to system.*

   To document to the customer that the installed system has been OG-300 certified by the Solar Rating and Certification Corporation (SRCC), the SRCC OG-300 sticker shall be attached to the front of owner's manual, and the separate OG-300 label shall be attached to system (usually on the solar storage tank).

4. *Customer has received required building permit(s) for the system installation.*

   Contractor shall secure all Building Permits required by law for the installation of a solar water heater and arrange or have the customer arrange for all required permit inspections.

B. Backup Water Heater

1. *Solar water heater serves primary auxiliary water heater(s).*

   The SWH must pre-heat water for the water heater(s) that supply the largest percentage of the hot water load at the residence.

2. *Auxiliary heater is electric, has a minimum capacity of 40 gallons, and both thermostats are set to 120° F (or not to exceed 140° F).*

   The auxiliary water heater shall be electric, and both thermostats shall be set to 120° F, or not to exceed 140° F. A minimum of 40 gallons of auxiliary water heating is required to ensure customer has adequate service hot water capacity. An energized top portion of a single tank may be used if specification 3.D.31 is achieved by the non-energized bottom portion of the single tank.

3. *Anti-convective piping with sweat fittings is installed at hot water outlet and cold water inlet.*

   Anti-convective plumbing loops or traps connected with sweat fittings shall be installed to inhibit hot water migration through the piping system. These loops or traps shall have a minimum 8-inch vertical drop to constitute an effective convective heat barrier. These loops or traps shall be located within close proximity to the tank. Heat trap nipples alone are not reliable in stopping heat migration, and will not meet this specification. The use of flexible copper pipe connectors with threaded fittings will not meet this specification due to potential leakage from the gaskets.

4. *Closed cell pipe insulation with a minimum ¾-inch wall thickness is on all exposed hot water pipes and first 5' of exposed cold-water inlet piping.*

   All exposed hot water pipes and the first 5' of exposed cold water inlet piping connected to auxiliary water heater shall be insulated with minimum ¾-inch closed cell pipe insulation to reduce heat loss through the piping.

5. *If auxiliary tank replaced, energy factor is 0.93 if < 60 gal or 0.91 if ≥ 60 gal.*

   To minimize standby heat losses and improve overall system performance, a new auxiliary water heater with volume of less than 60 gallons shall have an Energy Factor of 0.93 or better. Models with volume equal to or greater than 60 gallons shall have an Energy Factor of 0.91 or better.

6. *If auxiliary water heater is replaced or moved, and located over wood framed floor, drip pan with pipe routed to drain or outside is installed.*

   To avoid possible structural damage should the back up water heater leak, if auxiliary water heater is replaced or moved as part of the solar water heater installation, and is located over a wood framed floor (in heated or unheated space), a drip pan with attached drain pipe routed to a positive drain or outside the structure is installed per local building code.

7. *Auxiliary tank is insulated to the Program standards. If in Oregon, and insulated to OSEIA standards, industry sticker is on the tank.*

   To minimize standby tank heat losses and to maximize efficiency, the auxiliary tank shall be insulated to the levels in the table:

   The following tank insulation requirements apply to solar water heating systems which have only one storage tank, such as thermally stratified active systems, or the auxiliary tank in systems with two tanks.

Tank Location	Insulation Requirement
In conditioned space[4] on concrete floor[6]	R-10 bottom pad[1]
In conditioned space[4] above insulated wood framed floor	No additional insulation required
In unconditioned space[5]	R-10 bottom pad[1] R-8 top pad[2] R-10 side wrap[3]
In unconditioned space[5]	0.91 EF "new" tank ≥ 60 gallons 0.93 EF "new" tank < 60 gallons R-10 bottom pad[1]

1 R-10 bottom pad must be high density foam designed for use under water heaters and have an R-value of 10 hr-^{o}F-ft^{2}/Btu.

2 R-8 top pad must be either 3.5 inches of standard density fiberglass insulation, 3 inches of high density fiberglass insulation, or 3/8" layer of reflective foil-coated bubble wrap installed with a ½" air gap between the insulation and the top of the tank. The top pad must have an effective R-value of 8 hr-^{o}F-ft^{2}/Btu.

3 R-10 side wrap must be placed around the entire exterior of the tank and have an effective R-value of 10 hr-^{o}F-ft^{2}/Btu. Insulation wraps that use a 3/8" layer of reflective foil-coated bubble wrap must be installed with a ½" air gap between the insulation and the side of the tank.

4 Conditioned space is inside the heated portion of the building.

5 Unconditioned space is in the unheated portion of the building, such as the garage, unheated portions of the basement or an unheated utility room.

6 Concrete floors refer to slab on grade or basements; rug or wood flooring with less than an R-15 layer of insulation beneath them must also meet this insulation requirement.

8. *If auxiliary tank has added side wrap insulation, access panels to electric heating elements are left uncovered, and side wrap insulation is continuously secured at panel openings.*

   To enable easy access for servicing, and to avoid potential overheating of internal wiring, the access panels to the back up water heater electric elements and thermostats shall be left uncovered by any added side wrap insulation. Furthermore the side wrap insulation shall be securely and continuously attached along all edges of the access panel openings.

C. Collector Siting, Orientation, and Mounting

1. *Collector location has PSF of 0.85 or better, as calculated from lowest edge of the collector(s). If PV powered system, PSF is 1.00.*

   The location of solar collectors shall have adequate exposure to sunlight. The collector location must have the minimum Prime Solar Fraction (PSF) of 0.85 or better within the solar window of 8:00 a.m. to 4:00 p.m., as calculated from the middle of the lowest edge of the collector(s). If the system is powered by a photovoltaic (PV) module, the PSF shall be 1.00, so there will be no shading of the collectors or PV module year round. Shading can disable this type of system. The PSF shall be determined by the contractor by completing a Bonneville sunchart prior to installation and verified by the Utility at the time of inspection.
2. *Collectors are oriented 40 degrees E or W of due south with a tilt angle of 14 to 50 degrees; or non-PV powered systems may also be oriented 41 to 90 degrees W, roof pitch of 5/12 or less, and with a tilt angle of 14 to 30 degrees*.

   To ensure adequate exposure to incident solar radiation, the solar collectors shall be oriented within 40 degrees E or W of due south with a tilt angle of 14 to 50 degrees; or non-PV powered systems may also be oriented within 41 to 90 degrees W, on a roof with a pitch of 5/12 or less, and with a tilt angle of 14 to 30 degrees.

3. *If PV powered system, the module is attached to or mounted within 6 feet of the collector(s).*

   To ensure module power delivery to the DC pump corresponds with solar radiation incidence on the thermal collectors, the panel shall be attached to the frame of the collector or mounted within 6 feet of the collector at a nearby location.

4. *Collector mounting is per manufacturer's specifications*.

   To comply with warranty provisions and ensure long-term integrity of the system, collectors shall be mounted according to manufacturer's specifications.

5. *Framework will resist deterioration.*

   To maintain structural integrity of the support system and the collectors, all mounting components, racking materials, and collector framework shall resist deterioration. Wood shall be pressure treated; steel shall be primed and painted to prevent rust; aluminum shall be anodized. Joiners and fasteners shall be of similar, non-reactive metals of adequate strength.

6. *Solar collectors are raised off roof surface or properly flashed to the roof.*

   To prevent buildup of debris and roof leaks due to standing water and/or ice dams, collectors shall be raised off roof surface a minimum of 11/2 inches, or properly flashed to shed water and snow.

7. *All roof penetrations are permanently sealed using appropriate materials and techniques.*

   To prevent roof damage and water leaks, all roof penetrations shall be permanently sealed. Pipes shall be run through properly installed roof pipe jacks. Lag screw and spanner bolt penetrations for collector mounting shall have metal flashing (except on metal or composition type roofs), and shall be sealed in and around the holes and over the entire fastening assembly. Sealant used shall be 20 year silicone sealant.

D. Equipment and Installation (All systems)

General

1. *System operates properly*.

   System shall be fully operational according to its design.

2. *All solar system components are new (not used)*.

   To ensure customer's warranty protection for the equipment and installation and to ensure system reliability and performance, only new system components and materials shall be utilized.

3. *All components, including solar storage and auxiliary tanks, are located to allow access and are adequately protected*.

   To facilitate servicing and/or replacement of system components, the installation shall be configured to provide adequate access to all parts and components of the system, including solar storage and auxiliary tanks. "Adequate" access means:

   a. not having to remove tanks or permanently affixed building components in order to access system components for servicing, and
   b. not having to remove permanently affixed building components in order to access system components for replacement.

   The installation shall also be configured to provide adequate protection of all system components from potential damage due to occupant traffic or activity.

4. *Means for changing the sacrificial anode rod has been provided.*

   To maximize solar storage tank longevity, the solar storage tank shall be installed to facilitate the periodic servicing and replacement of the tank's sacrificial anode rod.

5. *The solar storage and auxiliary tanks and related components (excluding collectors and integral passive systems) are located in an enclosed tempered space.*

   To protect the system from freezing conditions, the solar storage tank, auxiliary tanks, and related components (excluding collectors and integral passive systems) shall be located in a totally enclosed, tempered, and weatherproof space. It is recommended this space be insulated. A "tempered" space can be one of the following:

   a. An interior heated space
   b. A fully enclosed, weatherproof space that is consistently warmed (tempered) in the winter to above freezing temperatures due to
      (1) A common wall with, and a door opening into, a heated space and/or
      (2) A consistent source of supplemental heat (such as a water heater, freezer, portable heater, etc.) sufficient to maintain the space above 32^{o}F during periods of winter design dry bulb temperatures for the location. A detached fully enclosed exterior space with adequate supplemental heat would meet this specification.
   c. A fully enclosed basement located under a heated living space, with a concrete floor and below grade walls, and not subject to outdoor ambient air flow.
   d. A fully enclosed and insulated structure located in a vented crawl space under the insulated floor of a heated living space. The structure shall have R-11 minimum insulated framed walls extending from grade level to the insulated floor above, and a hinged, positively latched and insulated access door sized to allow full access for monitoring system performance and servicing system components.
   e. A fully enclosed outdoor shed that is attached to a common wall with a heated space. The shed shall have weatherproof, R-19 minimum insulated walls and roof, concrete floor, or wood floor insulated to R-19, and a hinged, positively latched, insulated, and weather stripped access door sized to allow full access for monitoring system performance and servicing system components.

6. *Any building insulation (attic, floor, wall), disturbed due to system installation, is restored to previous condition.*

   To preserve pre-existing building insulation levels, contractor shall re-fluff, add to, replace, or re-attach in a workmanlike manner, any existing insulation and its support that was disturbed during system installation. It is recommended that the contractor document any pre-existing or other damage, not due to the solar installation, and submit it to both the customer and the Utility.

7. *All penetrations to building shell are sealed.*

   To prevent intrusion by insects or vermin, all penetrations to building shell (walls, etc.) resulting from installation of the solar system shall be permanently sealed with appropriate water and pest proof materials.

8. *Monitoring/maintenance instructions per Bonneville/Utility specifications are plainly mounted/displayed in plastic job ticket holder.*

   Monitoring and maintenance instructions, as approved by Bonneville/Utility for each SWH type, shall be mounted in a plastic job ticket holder in a plainly visible location near the solar storage tank. For ICS and Thermosyphon systems, these shall be mounted near the auxiliary water heater. These instructions shall include:
   a. Clear instructions on how to monitor system performance.
   b. Description and recommended frequency of homeowner maintenance.
   c. Diagram of system noting location of valves and monitoring devices.
   d. What to do and who to call in an emergency and when the system needs professional maintenance or repairs.
   e. How to protect the system from overheating due to stagnation during periods when system is not in use during summer months.

9. *Monitoring devices are installed and are easily visible*.

   To determine easily that system is operating and is delivering solar heated water, monitoring gauges and valves must be installed and must be easily accessible and visible.

10. *Corrosion between dissimilar metals has been avoided in all structural components*.

    Like or compatible metals shall be used to prevent corrosion between dissimilar metals.

11. *The potable water supplied to the solar storage tank meets minimum quality standards.*

    To maximize the operational life of the solar storage tank and in some cases other solar system components, the potable water supplied to the system shall meet the following minimum water quality standards:
    a. less than 1000 ppm total dissolved solids
    b. less than 500 ppm total hardness
    c. less than 400 ppm total alkalinity

Plumbing/Piping

12. *There are no leaks in the system plumbing.*

    All plumbing and connections are installed properly to ensure no fluid leakage in the system.

13. *All piping in the system is copper or cross-linked polyethylene type, and all fittings are either copper or brass. Cross-linked polyethylene piping connections are made with compression fittings.*

    To ensure there is no failure in the piping and fittings due to high operating temperature or pressure, all pipes shall be copper or cross-linked polyethylene type, and all fittings are either copper or brass. To ensure highest possible reliability, connections in or to cross-linked polyethylene piping shall be made with only brass or copper compression fittings. Cross-linked polyethylene piping is rated to only 180°F and therefore is not acceptable for collector loop piping in active systems. Galvanized fittings and nipples, and PVC, CPVC, and polybutylene pipe shall NOT be used for any plumbing in the system.

14. *Potable pressurized plumbing in unheated overhead spaces is cross-linked polyethylene type piping or (optionally) Type L rigid copper if a draindown system.*

    In applications where potable pressurized plumbing is used in unheated overhead spaces, cross-linked polyethylene type piping shall be used. Optionally, Type L rigid copper may be used for draindown systems only. These materials will better withstand expansion and contraction due to fluid temperature fluctuations. The type L rigid copper will withstand higher potable water temperatures that may occur during draindown system high-limiting and collector refill.

15. *Cross-linked polyethylene piping in unheated overhead spaces is continuous with no connections within the unheated overhead space.*

    To avoid possibility of fluid leaks that could cause damage if piping connections were located in attics or other unheated overhead spaces, cross-linked polyethylene piping used in unheated overhead spaces shall be continuous with no connections within the unheated overhead space.

16. *Brass unions or nipples are used between all dissimilar metals*.

    To prevent corrosion and fluid leaks, only brass unions or nipples shall be used between plumbing components made of dissimilar metals. The use of dielectric unions will not meet this specification due to potential water leakage from the gaskets.

17. *Piping runs are adequately and appropriately supported*.

To ensure correct system operation, and to preserve the integrity of joint seals, piping runs shall be well supported using appropriate materials. Follow these minimum support spacing requirements:

Pipe Type	Run Type	Maximum Spacing
Rigid Copper	Horizontal	6 feet
	Vertical	6 feet
Flex Copper	Horizontal	6 feet
	Vertical	6 feet
Poly or PEX	Horizontal	4 feet
	Vertical	4 feet

To ensure long term integrity and performance of the pipe insulation, the supports shall not compress or damage the pipe insulation.

18. *High temperature rated closed cell foam pipe insulation with a minimum ¾-inch wall thickness is installed on all pipes in the system. R-12 minimum insulation is installed on potable water piping exposed to outdoor temperature or in unheated spaces*.

To minimize heat loss and minimize risk of fluid freezing, closed cell pipe insulation with a minimum ¾-inch wall thickness shall be installed on all pipes in the system. R-12 minimum insulation shall be installed on any potable water piping exposed to outdoor temperatures or in unheated spaces over current or planned finished living areas. In colder climates, higher R-values on potable piping may be advisable. To avoid degradation of the insulation due to solar system operating temperatures, the insulation material shall have minimum temperature ratings according to the table below. In situations where high stagnation temperatures are expected, higher temperature ratings on the insulation are encouraged. .

Piping Type	Minimum Temperature Rating Requirement
Active Systems	
Collector Loop	220°F
Passive Systems	
Hot Return	220°F
All Other Piping	180°F

19. *Pipe insulation is properly sized to fit pipe and continuously closed and sealed*.

    To minimize heat loss and prevent freezing, pipe insulation shall be continuously closed and sealed at all joints and seams. Pipe insulation shall be properly sized to fit the pipe.

20. *Pipe insulation exposed to the outside is adequately protected.*

    To prevent ultraviolet (UV) deterioration and damage of pipe insulation, all pipe insulation located outside the building shell and exposed to sunlight and weather shall be protected using one or more of the following methods:

    a. Continuously wrapped in an overlapping manner with adhesive backed aluminum foil tape and painted with an aluminum adhesive paint either dark brown or other customer approved color to match house exterior.

    b. Continuously wrapped in an overlapping manner with an adhesive backed UV- inhibited electrical tape.

    c. Continuously enclosed in a wood or metal chase painted to match house exterior. (Exterior wall applications)

    d. Continuously enclosed in UV inhibited ABS, PVC, or aluminum pipe or jacketing.

    e. Painted with exterior grade paint compatible with insulation type to match house exterior. (ONLY applicable for under eave or other outside locations not exposed to direct sunlight.)

21. *Underground piping is of the appropriate type and is fully enclosed with appropriately water proofed R-6 insulation designed for underground application, is protected from sharp objects, and is below frost line.*

    If underground piping is used for potable water, to ensure pipe will not burst should freezing occur, it shall be of the cross-linked polyethylene type. If underground piping is used for non-potable water in a collector loop, to ensure pipe will not degrade due to high temperatures, it shall be Type L copper. To minimize heat loss, all underground plumbing shall be insulated with a minimum R-6 insulation that has been appropriately water proofed. To protect the pipe, insulation, and water proofing material from chemical degradation, both the insulation and waterproofing system must be specifically designed for underground application. Trenches and backfill shall be free of sharp objects that could come in contact with and puncture the water proofing membrane, insulation, or pipe. Underground piping shall be below local frost line per local code.

22. *Underground cross-linked polyethylene piping is continuous with no connections along the lengths to be buried.*

    To avoid possibility of fluid leaks that would be difficult to detect and repair, cross-linked polyethylene piping in an underground application shall be continuous with no connections along the lengths to be buried.

Freeze Protection

23. *Approved freeze protection is provided*.

    Freeze protection, as noted in Section 2.3 and approved by Bonneville during qualification of each system type, shall be incorporated.

24. *If an antifreeze system: a vented, double wall or approved heat exchanger has been installed***.**

    To prevent cross-contamination between system fluid and potable water when using an antifreeze system, a vented, double wall heat exchanger shall be installed. The vent will reveal fluid leakage upon failure of the heat exchanger wall(s) indicating the need for replacement. Alternatively, a heat exchanger approved by the governing plumbing board may be used.

25. *High temperature propylene glycol antifreeze solution has been used.*

To avoid risk of a health hazard should the collector fluid come in contact with potable water, and to protect system components from corrosion caused by premature chemical breakdown of the antifreeze due to high collector stagnation temperatures, high temperature rated propylene glycol, mixed with distilled or deionized water shall be used. The propylene glycol shall be mixed in concentration with distilled or deionized water according to the lowest expected local temperature as noted in the following table. Because mixtures with higher percentages of propylene glycol can withstand higher temperatures, solutions of up to full strength heat transfer fluid may be used to extend fluid life. As a tradeoff, a higher propylene glycol to water concentration than shown in the table below will lower the heat transfer efficiency of the solution.

Temperature (degrees F)	Minimum percent (volume) glycol required
20	20%
10	31%
0	38%
-10	45%
-20	49%
-30	53%
-40	57%
-50	61%
-60	64%

Valves

26. *Fully ported isolation valves are installed, enabling bypass of solar system.*

To ensure the system can be isolated from the backup water heater in an emergency or for servicing or component replacement, fully ported valves are installed to enable bypass of the entire solar system. Brass ball valves are recommended.

27. A*nti-scald, pressure compensating tempering valve(s) are installed and are:*
    a) On the downstream side of the backup electric water heater(s).
    b) Located after anti-convective plumbing.
    c) Set no higher than 140^0 F.

    To ensure hot water distribution outlets in the residence are not capable of delivering scalding water, tempering valve(s) shall be installed and be of the commercial grade anti-scald and/or pressure compensating type and adjusted no higher than 140 degrees. The tempering valve(s) shall be installed on the downstream side of the backup electric water heater(s). The valve(s) shall be installed after anti-convective plumbing below the top of the back up water heater tank as defined in specification 3.B.3. This will prolong the valve's life by protecting valve components from constant exposure to high water temperatures. This will also avoid hot water migration through the tempering valve and into the cold water feed line, which could compromise the effectiveness of the valve. It is recommended the valve(s) be plumbed with brass unions on either side to allow future repair or replacement. Exercising the valves during servicing avoids potential freeze-up of the valve.

28. *All valves, gauges and instruments are labeled per Bonneville specifications.*

    To identify and describe the purpose and operation of specific devices in the system, all valves, gauges, and instruments shall be labeled. Permanent tags shall be attached to each valve, gauge, or instrument, incorporating Bonneville approved descriptions that include the following:
    a. Name/identification of the valve, gauge, or instrument.
    b. Purpose of the valve, gauge, or instrument.
    c. Operation of the valve, gauge, or instrument.

    Labels with this information shall be attached to the tags. To ensure the labels stay affixed to the tags over time, plastic tags are used, or if stiff paper tags are used, the labels shall be covered with clear plastic packing tape or laminated to the tags.

29. *Temperature & Pressure relief valve is installed on solar storage tank.*

    To ensure safe relief of the solar preheated water in the event of overheating, a 210 degree F and 150psi valve shall be installed per local plumbing code requirements.

30. *Valves are supplied for filling, flushing, and draining collector loop and potable water piping.*

    To enable scheduled service and any needed repairs to the collector loop and potable piping, all valves as designated by the system manufacturer, SRCC OG300 specifications and/or Bonneville will be supplied for filling, flushing, and draining the collector loop and potable water piping.

Solar Storage Tank

31. *Minimum solar storage tank capacity of 1.25 gallons/square foot of collector net area is provided.*

    To ensure adequate system fluid heat collection efficiency, a minimum solar storage tank capacity of 1.25 gallons/square foot of collector net area shall be provided. It is recommended that 1.75 gallons per square foot of collector net area be provided.

32. *Electric power is not connected to a roof-mounted tank or the solar tank (except for wiring to upper element on non-roof-mounted, single tank systems).*

    To provide the maximum capability of the system to capture solar heat, electric power shall not be connected to a roof-mounted tank or the solar tank, except for wiring to an upper element on non-roof-mounted, single tank systems.

33. *Solar storage tank is insulated to Program standards. If in Oregon, and insulated to OSEIA standards, industry sticker is on the tank.*

To minimize standby tank heat losses and to maximize efficiency, the solar storage tank shall be insulated to the levels in the table:

The following insulation requirements apply to the solar storage tank in a two tank system. These tanks do not have a means of heating the water other than solar energy and are almost always located upstream of the auxiliary tank. Solar tanks are generally located in unconditioned space[5] because of their size and because they are usually not part of the original home design.

Tank Type	Conditioned Space[3] Insulation Requirement	Unconditioned Space[4] Insulation Requirement
80 gallon Rheem/Ruud tank with external wrap around heat exchanger	R-10 bottom pad[1] if on concrete[5] R-10 side wrap[2]	R-10 bottom pad[1] R-10 side wrap[2]
Water heater tank with internal, double-wall coil heat exchanger	R-10 bottom pad[1] if on concrete[5] 0.91 EF "new" tank	R-10 bottom pad[1] 0.91 EF "new" tank
Other water heater tank without integral heat exchanger	R-10 bottom pad[1] if on concrete[5] 0.91 EF "new" tank	R-10 bottom pad[1] 0.91 EF "new" tank

1 R-10 bottom pad must be high density foam designed for use under water heaters and have an R-value of 10 hr-^{o}F-ft^{2}/Btu.
2 R-10 side wrap must be placed around the entire exterior of the tank and have an effective R-value of 10 hr-^{o}F-ft^{2}/Btu. Insulation wraps that use a 3/8" layer of reflective foil-coated bubble wrap must be installed with a ½" air gap between the insulation and the side of the tank.
3 Conditioned space is inside the heated portion of the building.
4 Unconditioned space is in the unheated portion of the building, such as the garage, unheated portions of the basement or an unheated utility room.
5 Concrete floors refer to slab on grade or basements; rug or wood flooring with less than an R-15 layer of insulation beneath them must also meet this insulation requirement.

34. *If solar storage tank is located in space where water leakage could cause structural damage, drip pan with pipe routed to drain or outside is installed.*

To avoid possible damage should the tank leak, if the solar storage tank is located in space where water leakage could cause structural damage (e.g., inside the home, on top of wood flooring, etc.) a drip pan with attached drain pipe routed to a positive drain or outside the structure is installed per local building code.

35. *Anti-convective piping with sweat fittings is installed on cold water supply inlet at top of solar storage tank.*

    An anti-convective plumbing loop or trap connected with sweat fittings shall be installed to inhibit hot water migration through the cold water supply piping to the solar storage tank. This loop or trap shall have a minimum 8-inch vertical drop to constitute an effective convective heat barrier. This loop or trap shall be located within close proximity to the tank. Heat trap nipples alone are not reliable in stopping heat migration, and will not meet this specification. The use of flexible copper pipe connectors with threaded fittings also will not meet this specification due to potential leakage from the gaskets.

E. Passive Systems (Thermosiphon, ICS, and Hybrid ICS)

1. *Roof-mounted solar storage tanks and ICS systems have adequate structural support per manufacturer's specifications.*

    To maintain the integrity of the system and prevent damage to the dwelling's roof or roof framing, the roof-mounted solar storage tank or Integral Collector Storage (ICS) system shall be adequately supported per manufacturer's specifications and/or local building code requirements.

2. *The potable water inlet and outlet piping on roof-mounted tanks and ICS systems is type L copper or brass and is piped to directly above the roof jack, where the connection to non-metal piping is made*.

    To keep the very hottest collector water from affecting the non-metal pipe causing damage or bursting, the potable water inlet and outlet piping on roof-mounted tanks and ICS systems shall be type L copper or brass and piped to directly above the roof jack, where the connection to non-metal piping shall be made.

3. *Incoming supply line pressure to the system does not exceed 70 psi, and pressure reducing valve (if required) is properly located.*

    To limit incoming pressure to meet rated equipment tolerances and/or limit expansion valve discharge due to pressure buildup in the system, the incoming supply line pressure to the system shall not exceed 70psi. If the incoming supply line pressure to the system exceeds 70psi, a pressure-reducing valve shall be installed and set to 70psi or less to control the inlet pressure. The pressure-reducing valve shall be located on the incoming water supply line upstream of all plumbing and components associated with the solar and back-up water heating system.

4. *A 90psi (150psi for ICS) cold-water expansion valve is installed in the collector/solar storage tank supply piping downstream of any pressure reducing valve, check valve or backflow preventer, and in an area not subject to freezing and routed to a positive drain.*

   To relieve pressure buildup in the system and protect system components without wasting energy or hot water, a cold-water expansion valve (pressure only valve) shall be installed to expel cold water during periods of high system temperatures. A 90psi expansion valve shall be used for all thermosiphon systems, and a 150psi expansion valve shall be used for all ICS systems unless otherwise specified by the system manufacturer. The expansion valve shall be installed downstream of any pressure reducing valve, check valve or backflow preventer on the cold inlet supply piping to the collector/solar storage tank, be located in an area not subject to freezing, and be routed to a positive drain or to outside the residence perimeter foundation.

5. *A check valve is installed in the cold water supply line before the cold water expansion valve for thermosiphon and ICS systems.*

   To prevent emptying of the collector/solar storage tank should the cold water supply be interrupted, a check valve (or equivalent) shall be installed in the cold water supply line to the collector/solar storage tank for thermosiphon and ICS systems. The check valve shall be installed on the upstream side of the cold water expansion valve.

6. *A thermometer is installed between solar storage and auxiliary water heater tank in the inlet piping to and near the top of the auxiliary tank.*

   To monitor the temperature of the solar pre-heated water, a thermometer shall be installed between the solar storage tank and the auxiliary water heater in the inlet piping to and near the top of the auxiliary tank in an easily visible location.

7. *Pressure relief valve at ICS collector outlet or temperature /pressure relief valve on solar tank are piped to drain per manufacturer's guidelines.*

   To minimize risk of scalding water coming in contact with persons, pets, or landscaping, the pressure relief valve at ICS collector outlet or temperature/pressure relief valve on the roof-mounted solar tank shall be plumbed to ground, drain or gutter per manufacturer's specifications.

8. *Vacuum Tube Integrated Collector Storage systems include:*
   a. *Circulation loop for high limit heat transfer with a differential controller, a check valve and pump in the piping from the collector(s).*
   b. *Meets Specifications F. 3-7, 11-13, 20, & 31.*
   c. *Expansion tank is installed when number of tubes is greater than four*.

   To minimize the effects of overheating during stagnation and transfer the heated water directly to the backup tank, a high limit heat transfer circulation loop shall be installed utilizing a differential controller, a check valve and a pump. The controller setup shall be: a 5-10 degree differential, pump activation at 160 degrees with high limit at 180 degrees. To control greater pressure fluctuation (expansion/contraction) with larger system arrays, an expansion tank shall be installed when the number of tubes is greater than four. This system shall additionally meet Specifications F. 3-7, 11-13, 20, & 31 in active systems.

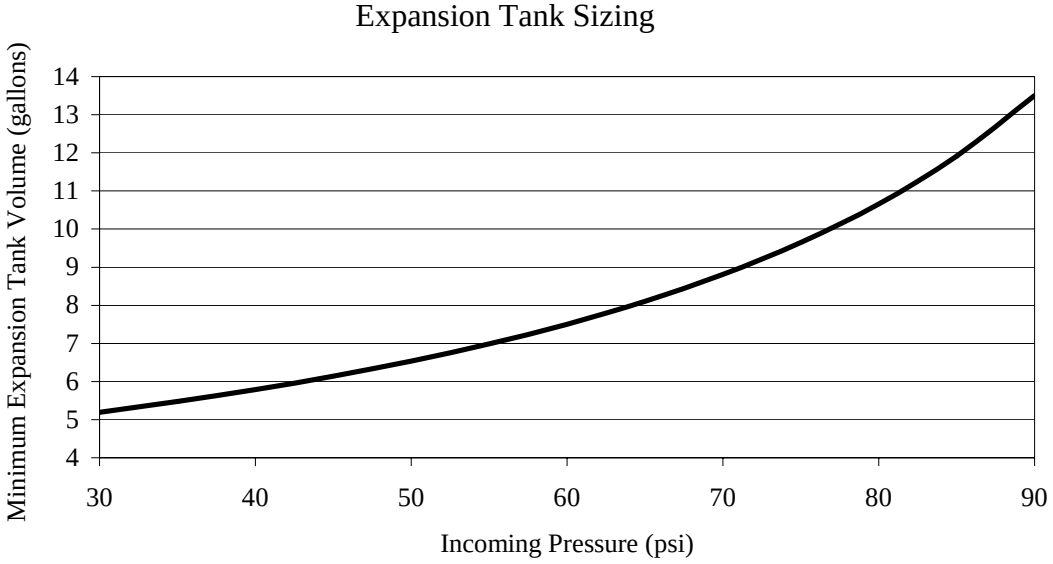
F. Active Systems (All)

1. *Incoming supply line pressure to the system does not exceed 90psi, and pressure reducing valve (if required) is properly located.*

   To avoid potentially damaging pressure build up from high potable water temperatures in the system, and resulting unwarranted discharge of temperature and pressure relief valves, the incoming supply line pressure to the system shall not exceed 90psi. If the incoming supply line pressure to the system exceeds 90psi, a pressure reducing valve shall be installed and set to 90psi or less to control the inlet pressure. The pressure-reducing valve shall be located on the incoming water supply line upstream of all plumbing and components associated with the solar and back-up water heating system.

2. *If a pressure reducing valve, check valve, and/or back flow preventer is/are on potable supply line to the system, a properly sized and located expansion tank is installed.*

To avoid potentially damaging pressure build up from thermal expansion of the potable water in the system, and resulting unwarranted discharge of temperature and pressure relief valves, if a known and verifiable pressure reducing valve, check valve, and/or back flow preventer exist on the cold water supply line to the system, a properly sized expansion tank shall be installed on the potable water piping in the system. The expansion tank shall be sized according to the expansion tank manufacturers recommendations or ASHRAE calculations. The following table shows appropriate expansion tank sizes using calculations from the year 2000 version of ASHRAE's HVAC Systems and Equipment Handbook for a 130 gallon system: (i.e., potable water volume in both solar storage and back-up tanks). Note: Smaller volume systems may require smaller expansion tanks; larger volume systems may require larger expansion tanks.



The air charge pressure in the expansion tank shall be adjusted to match the inlet water supply pressure before installation and shall be installed according to manufacturer's recommendations. The expansion tank shall be located either between the solar storage tank and the back-up water heater, or before the solar storage tank and after any pressure-reducing valve, check valve, or backflow preventer in the cold water supply line.

3. *Collector loop plumbing has been thoroughly flushed and pressure tested prior to charging with collector fluid and system startup.*

   To ensure system operation is not jeopardized by any debris or impurities that may have entered the collector loop piping as system components were plumbed, and to ensure the collector loop piping will not leak when charged and system is operating, the piping shall be thoroughly flushed with clean water, and fully pressure tested prior to charging with collector fluid and system startup.

4. *Fluid has an adequate flow rate and circulates in proper direction*.

   To ensure the heated fluid from the collectors is transferred to the solar storage tank, the fluid must flow from the top of the collectors to the solar tank and with a flow rate appropriate to the size and type of system.
   For forced circulation systems, the recommended range of flow rates is 0.015 – 0.04 gallons per minute (gpm) per sq. ft. of collector area. The table below shows acceptable flow rates for typical system sizes:

Gross Collector Area	Flow Rates
40 sq. ft.	0.5 – 2 gpm
64 sq.ft.	1 – 3 gpm
80 sq. ft.	2 - 4 gpm

   PV powered systems have variable flow rates, with a typical range of 0.2-2.0 gpm. Maximum flow rates in full sun conditions are typically 1.5-2.0 gpm.

5. *Circulation pump is installed with shaft oriented horizontally.*

   To ensure the pump shaft is continuously immersed in and lubricated with collector fluid, which will help prolong pump life, the circulation pump shall be installed with the shaft oriented horizontally.

6. *System has been designed to allow for isolation of the circulation pump.*

   To enable servicing and/or replacement, isolation unions, ball valves, check valves, or pumps with built in isolation features shall be installed.

7. *Controller has correct settings and is mounted within 6 ft. of solar storage tank, hard-wired or plugged into nearest outlet, and wiring is securely attached.*

   To ensure correct system operation the differential controller shall turn the circulation pump on at a 10 to 15 degree differential between the solar storage tank and the collectors and it shall turn the circulation pump off at a 4 to 6 degree differential. The controller shall also have a 180 degree maximum high limit setting and the controller sensors shall be pre-tested for accuracy. To allow for monitoring and diagnostic servicing of the system, the controller shall be mounted within 6 ft. of the solar storage tank, hard-wired or plugged into nearest outlet (twist locks are acceptable) with the wiring securely attached to parts of the system or adjacent walls or ceiling.

8. *If PV powered system, the PV module is connected to the DC pump with wiring of appropriate gauge and type, and is installed through a dedicated roof jack with exterior conduit.*

   To minimize line loss and ensure adequate power is delivered and maintained from the photovoltaic (PV) module, the wiring connecting the PV module and the DC pump shall be of an appropriate gauge (dependent on one-way distance), be ultraviolet resistant, and routed through a separate roof jack with exterior electrical conduit. The electric wire shall be bare or tinned copper, two conductor, PVC insulated, and have a PVC UV rated gray jacket suitable for exterior use or equivalent as per the National Electric Code (NEC). The conduit shall be secured to a roof-framing member and all the wiring shall follow local code and manufacturer's guidelines.

9. *If PV powered system, a DC rated on/off switch is installed between the PV module and the circulating pump.*

   To allow system diagnosis and servicing, a DC rated on/off switch shall be installed between the photovoltaic (PV) module and the circulation pump. The switch shall be installed in an easily accessible location and labeled according to Specification 3.D.28.

10. *If PV powered system, a high temperature limit shutoff function is installed and wired through the circulation pump.*

    To limit possible high water temperature in the solar storage tank, a high temperature limit-switching sensor shall be installed on the system. The sensor may be attached to the hot water outlet nipple or piping at the top of the tank, or against the tank's inner shell near the top of the tank, but not in direct contact with the tank's heat exchanger. If mounted on piping, the sensor shall be insulated with minimum R-3/4 inch closed cell pipe insulation. The sensor shall be wired through the circulation pump in a manner that will interrupt pump operation when 180°F high temperature near the top of the tank is reached.

11. *Sensors are placed correctly, attached securely, and adequately insulated. Plug sensor is installed on solar tank when a fitting is provided.*

    To ensure correct system operation, a strap type sensor shall be located at the hot outlet of the collector(s) and secured with a stainless steel hose clamp. The tank sensor, if strap type, shall be attached directly against the inner tank shell and not in contact with any heat exchanger, or any other location that will accurately measure water temperature near the bottom of the tank. When a fitting is provided on the solar storage tank, a plug-type sensor shall be threaded into the tank fitting. Sensors mounted on piping shall be insulated with minimum ¾ inch wall closed cell pipe insulation.

12. *Sensor wiring has UV-rated exterior jacketing, is continuously attached, and is protected from abrasion, contact with 110V/220V lines/conduit, weather and high temperature, and has solid connections.*

    To ensure long life for the sensor wiring, all sensor wire shall have UV-rated exterior jacketing, be continuously and securely attached to the exterior of insulated collector loop piping (i.e., not dangling or loose), and be protected from damage due to abrasion, weather and high temperatures. Contact with hot pipes and 110V/220V electrical lines and conduit shall be avoided. To ensure correct system operation, the sensor wiring connections shall be permanently joined using crimp-type connectors and then sealed with silicone. Braided wire is recommended. It is recommended to shield the sensor wire in areas with a potential for electrical interference.

13. *Flow meter is provided*.

    To monitor the fluid flow rate in the system, a flow meter shall be installed in the vertical piping to the collector(s) in an easily visible location.

14. *Thermometer is provided at hot water outlet port on solar storage tank*.

    To monitor temperature of the solar pre-heated water, a thermometer shall be installed at the hot water outlet port on the solar storage tank in an easily visible location. A readout of the temperature on a digital controller is allowed in lieu of a separate thermometer if the homeowner is educated on how to obtain this reading using the controller.

Active Antifreeze Systems

15. *Fill valve has a label indicating non-toxic heat transfer fluid to be used.*

    As a health notice warning and as a guide for the scheduled changing of fluid, a label indicating only non-toxic fluid type shall be attached to the fill valve.

16. *Fill and drain valves have leak-proof caps.*

    To prevent unwanted release of collector fluid under pressure, should the fill or drain valves be accidentally opened, all fill and drain valves shall have leak-proof caps installed.

17. *Pressure gauge is installed in the collector loop and the operating pressure is within 10-45 psi.*

    To verify the operating pressure in the collector loop, a pressure gauge shall be installed in a visible location in the collector loop. The typical acceptable operating pressure range is 10-45 psi.
    Note: For system diagnosis, the cooler the operating temperature, the less pressure the gauge will register in the collector loop. On very sunny and hot days, the pressure may exceed 45 psi.

18. *A 150 psi pressure relief valve piped to drain is installed on the return line from the collectors.*

    To prevent damage of collectors and/or collector loop piping as pressure builds during stagnation, a 150 psi pressure relief valve, piped to drain shall be installed on the return line from the collectors.

19. *A check valve is installed on return line from collectors near inlet to heat exchanger.*

    To minimize nighttime convective heat loss from solar preheated water in the solar storage tank, a check valve shall be installed on the return line of the collector fluid loop near the inlet to the heat exchanger.

20. *A correctly sized and rated expansion tank is installed on supply line to collectors.*

    To control pressure fluctuation during expansion and contraction of the collector fluid, a correctly sized and rated expansion tank shall be installed on the supply line to the collectors. For standard one and two panel systems, the expansion tank shall have a total tank volume of no less than 4.4 gallons, and shall have a minimum operating pressure of 150 PSIG. Larger systems shall have an appropriately sized expansion tank according to manufacturer's or ASHRAE sizing recommendations. To enable more complete purging of air from the collector loop it is recommended to mount the expansion tank in an upside down configuration.

21. *A threaded plug fitting is installed at the high point in the collector loop and is insulated.*

    To enable air or gas removal in the collector piping system, a threaded plug fitting is installed at the high point in the collector loop. To prevent freezing and consequently allow for correct operation, the fitting shall be insulated with a minimum ¾ inch wall closed-cell type insulation without covering the vent port.

Active Drainback Systems

22. *Collectors are pitched a minimum of 1/8 inch per foot to inlet and piping is continuously pitched between collector and drainback reservoir with a minimum 1/8 inch per foot.*

    To allow the fluid to completely drain from the collectors and piping exposed to freezing conditions back to the system reservoir tank, the collectors shall be pitched a minimum 1/8 inch per foot to the inlet, and piping shall be pitched between collector and drainback reservoir a minimum 1/8 inch per foot.

23. *There are no inverted U-loop piping configurations between the storage tank and the pump.*

    To ensure air cannot get trapped in the collector loop piping, which can cause the pump to cavitate and prematurely fail, there shall be no inverted U-loop piping configurations between the storage tank and the pump.

24. *A 150psi pressure relief valve is installed on drainback tank*

    To relieve system pressure buildup, a 150 psi pressure relief valve shall be installed on the drainback reservoir tank and piped per local plumbing code.

25. *Drainback tank is insulated to Program standards for solar storage tanks.*

    To minimize heat loss and enhance system efficiency, the drainback reservoir tank shall be insulated to the Program standards for solar storage tanks or equivalent, as found in Specification D.33.

26. *Distilled or deionized water and a suitable corrosion inhibitor have been used in the collector loop piping.*

    To safeguard all components in the collector loop and to prevent scaling build up, distilled or deionized water and a corrosion inhibitor that is chemically compatible with the collector loop components shall be used in the collector loop.

27. *Fill and drain valves have leak-proof caps.*

    To prevent unwanted release of collector fluid should the fill or drain valves be accidentally opened, all fill and drain valves shall have leak-proof caps installed.

Active Draindown Systems

28. *Collectors are pitched a minimum of 1/8 inch per foot to inlet and piping is continuously pitched between collector and draindown valve(s) with a minimum 1/8 inch per foot.*

    To allow fluid to completely drain from the collectors and piping exposed to freezing conditions back to the system draindown valve(s), the collectors shall be pitched a minimum 1/8 inch per foot to the inlet and piping shall be pitched between collector and draindown valve(s) a minimum 1/8 inch per foot.

29. *The system tanks, vents, valves, pumps, and discharge piping are located in an enclosed, insulated space.*

    To protect against freezing conditions and possible system damage, the system's tanks, vents, valves, pumps, and discharge piping shall be located in an enclosed, insulated space. Because the working fluid in draindown systems is pressurized potable water, the components of this system and in particular the draindown valve are more susceptible to damage in freezing weather conditions.

30. *Automatic air vent and vacuum relief valve are installed at the high point in the collector loop and are insulated.*

    To ensure air or gas removal in the collector piping system, an automatic air vent and a vacuum relief valve shall be installed at the high point in the collector loop. To prevent freezing and consequently allow for correct operation, these valves shall be insulated with a minimum of ¾-inch wall closed-cell type insulation without covering the valve caps or vent ports.

31. *A Y-type strainer is installed in collector loop on supply side of the circulation pump.*

    To enable capture and removal of sediment from potable water being supplied to the system, which could cause damage to and/or failure of system control valves or other components, a Y-strainer shall be installed at the low point in the collector loop on the supply side of the circulation pump.

32. *Drain line from the draindown valve is minimum 1/2" rigid copper pipe with a 1/4" per foot pitch to a positive drain and plumbed to within 12" of the valve. Transition poly tubing from the valve is inserted 3" into the copper pipe.*

To ensure the system has the ability to adequately drain (especially in freezing conditions) and avoid any damage due to water being trapped in the collector(s) and/or piping, the drain line from the draindown valve shall be plumbed with a minimum 1/2" rigid copper pipe with a 1/4" per foot pitch to a positive drain. The copper piping shall also be plumbed to within 12" of the draindown valve. High temperature poly tubing shall be installed from the valve and inserted 3" into the copper drain line without a plumbing fitting. In the event of an obstruction in the copper drain line, the system will still have the capability to drain via overflow at the top of the copper drain line.

4. REFERENCES

- $ SRCC Document OG-300. Operating Guidelines and Minimum Standards for Certifying Solar Water Heating Systems; Solar Rating and Certification Corporation.
- $ Installation Guidelines for Solar DHW Systems in One and Two-Family Dwellings; U.S. Department of Housing and Urban Development.
- $ Progressive Tube, Installation and Operations Manual; Thermal Conversion Technology, 1997.
- $ Solahart Installation Manual, Model 300 Series. Solahart 1992.
- $ Solaray OG-300 Certified Solar Water Heating System, Type: DC Circulating Pump and Photovoltaic Module, Installation, Operation and Maintenance Manual; Sunearth Inc.
- $ Solar Sidebar, Installation Instructions. Heliotrope General.
- $ Residential Alternative Energy Tax Credit, Oregon Administrative Rules and Amendments. Oregon Office of Energy, 2002.
- $ Solar Hot Water System Reliability, 1994 Draft Report. National Renewable Energy Laboratory.

Conservation and Renewables Discount Program
Specification Changes for FY2005

Bright Way Solar Pool Heating General and Technical Specifications

Section	Summary	New Spec	Old Spec
Title	Spec. Purpose	General and Technical Specifications for Residential Summer Seasonal Solar Pool Heating Systems	General and Technical Specifications for Solar Pool Heating Systems
1.6	Purchase Date	None	Required systems to be purchased after a specified
3.C.1	Vinyl Covers Allowed	Allow opaque vinyl covers	Didn't specify opaque vinyl covers as being allowed
3.C.4	Outdoor Component Protection	Added specificity: Protect from damage due to weather and sunlight using a permanent awning, lean-to, or shed.	A cover was required, but specifics were not stated.
3.C.7	Documentation of Damage	Contractor recommended to document damage not due to the solar installation.	Contractor required to document.
3.C.12	Collector Pitch	Headers to be horizontal (level) or at a slight tilt toward inlet.	A tilt of 1/8 inch per foot required.
3.C.15	Flow Balancing	3.C.12 and 13. Detailed options for balancing multiple rows of collectors	Multiple rows of collectors must be balanced.
3.C.21	Hold-Down Straps	Mounting per manufacturer's instructions.	Require 3 hold-down straps.
3.C.25	Dielectric Unions	None	Dielectric unions required.
3.C.27	Ball Valves on system	Ball valves required on supply to and return from panels	Ball valve required on supply and check valve required on return.
3.C.29	Vacuum relief valve	One vacuum relief valve required on upper collector header.	Vacuum relief valve required for each row of collectors.
3.C.30	Check Valve - Filter	Check valve required after the filter.	Check valve required if filter is diatomaceous earth type.
3.C.34	Flow Meter	Flow meter installed per manufacturer's instructions.	Flow meter provided.

Bonneville Power Administration
THE BRIGHT WAY TO HEAT WATER™

GENERAL AND TECHNICAL SPECIFICATIONS
for
RESIDENTIAL SUMMER SEASONAL
SOLAR POOL HEATING SYSTEMS
July 6, 2004

1. GENERAL PROGRAM SPECIFICATIONS

1.1. The solar pool heater (SPH) must be installed at a residence with electric service provided by [UTILITY NAME].

1.2. The participating customer must be the owner of the property or the owner's legally assigned representative.

1.3. The swimming pool must be electrically heated.

1.4. Only solar pool heaters determined eligible by BONNEVILLE qualify for the Program. Owner-built systems do not qualify. Additions to existing systems may qualify with [Utility Name] prior approval, and providing the entire system meets the general and technical specifications for solar pool heating systems.

1.5 The eligible solar pool heater must be purchased from a contractor-determined eligible by [UTILITY NAME] to participate in the program.

1.6. The installed SPH must be inspected by a [UTILITY NAME] representative to determine compliance with all program requirements.

2. GENERAL EQUIPMENT SPECIFICATIONS

2.1. Equipment and systems must undergo a technical review by BONNEVILLE to be determined eligible for the Program.

2.2. Solar pool heating collectors shall be of the copolymer plastic type, carry a minimum 10-year full warranty, and be certified by the Florida Solar Energy Center.

Developed by Eugene Water & Electric Board

July 2004

2.3. Eligible solar pool heating systems shall incorporate freeze protection strategies that:

a. Are approved by BONNEVILLE during qualification of each system type,

b. Possess demonstrated or theoretical reliability in weather conditions common to the BONNEVILLE service territory,

c. Result in no lost electrical energy due to circulation of heated water during cold winter conditions, and

d. Incorporate valves to facilitate manual draining of the collectors and pipes prior to freezing weather conditions.

2.4. Equipment and installation shall comply with all applicable building, plumbing, and electrical codes. If applicable, building permits shall be procured.

2.5. All equipment and materials used in this program shall be installed according to manufacturers' specifications, those included in this document, SRCC OG-400 Standards and any others required by BONNEVILLE. BONNEVILLE reserves the right to require compliance with installation specifications that may exceed or differ from those of a manufacturer and/or SRCC.

3. INSTALLATION SPECIFICATIONS

A. Consumer Documents

1. *When applicable, customer has received building permit for the system installation.*

   Contractor shall secure all Building Permits required by law for the installation of a solar pool heating system and arrange or have the customer arrange for all required permit inspections.

2. *Customer has received contractor's installation and manufacturer's component warranties.*

   Contractor shall provide customer with a written warranty stating the equipment and installation will be free from all defects in workmanship and materials for at least two years from the date of final approval by [UTILITY NAME]. Warranty shall include all labor for any repairs within the warranty period. Manufacturers' component and material warranties shall be supplied to customer and may be used to satisfy part of this warranty requirement.

3. *Customer has received an owner's manual and complete operating instructions*.

   Contractor shall provide customer with a comprehensive owner's manual for the system, including detailed operation and maintenance instructions to help ensure effective and persistent system operation.

4. *Monitoring/maintenance instructions per [UTILITY NAME] specifications are plainly mounted/displayed*.

   Monitoring and maintenance instructions, as approved by [UTILITY NAME] for each SPH type, shall be mounted in a plainly visible location near the pool mechanical equipment. These instructions shall clearly include:
   a. How to monitor system performance.
   b. Description and recommended frequency of maintenance.
   c. Diagram of system noting location of valves and monitoring devices.
   d. How to drain the system to prevent freezing in winter.
   e. What to do and who to call in an emergency and when the system needs maintenance or repairs.

B. Auxiliary Pool Heater

1. *Auxiliary pool heater is electric.*

   The auxiliary pool heater shall be electric.

C. Equipment and Installation

General

1. *The swimming pool is equipped with a pool cove*r.

   The swimming pool shall be equipped with a pool cover that covers the entire pool surface. It is recommended the cover be the clear bubble type to maximize passive solar gains to the pool when the pool is covered during the day. Acceptable alternatives are insulating foam sheet-type, rubberized canvas, or opaque vinyl covers.

2. All solar system components are new (not used).

   To ensure customer's warranty protection for the equipment and installation and to ensure system reliability and performance, only new system components and materials shall be utilized.

3. *System operates properly*.

   System shall be fully operational according to its design.

4. *All system components are covered for protection from the weather.*

   All related solar system components (excluding collectors and piping) shall be adequately protected from damage and degradation due to weather and sunlight. At a minimum, all solar system control components shall be protected from overhead precipitation and direct sunlight by a permanent weatherproof awning, lean-to, or shed. It is recommended the components be located in a totally enclosed weatherproof space.

5. *All system components are located to allow access, are adequately protected, and do not interfere with pool maintenance functions.*

   All solar system components shall be installed in a configuration and manner that shall allow room for their servicing and/or replacement, protect them from any incidental damage, and avoid any interference with maintenance or replacement of any of the existing pool equipment (pumps, filters, chlorinators, heaters, etc.).

6. *Monitoring devices are installed to be easily visible*.

   All monitoring gauges and valves in the system must be installed to allow easy access to determine that system is functioning correctly.

7. *Any building insulation (attic, floor, wall), disturbed due to system installation, is restored to previous condition.*

   To preserve pre-existing building insulation levels, contractor shall re-fluff, replace, or re-attach in a workmanlike manner, any existing insulation and its support that was disturbed during system installation. It is recommended that the contractor document any pre-existing or other damage, not due to the solar installation, and submit it to both the customer and [UTILITY NAME].

Collector Location, Orientation, Mounting and Plumbing

8. *Collector location has PSF of 0.85 or better, as calculated from lowest edge of the collector(s), or PSF of .60 or better if ALL shading exists below the Mar 21 - Sep 21 sun line on the BONNEVILLE sunchart.*

   The location of solar collectors shall have adequate exposure to sunlight. The collector location must have the minimum Prime Solar Fraction (PSF) of .85 or better within the solar window of 8:00 a.m. to 4:00 p.m., as calculated from the middle of the lowest edge of the collector(s). This shall be determined by the contractor by completing a BONNEVILLE sunchart prior to installation and verified by [UTILITY NAME] at the time of inspection. Alternatively, the collector location may have a PSF of .60 or better if ALL shading exists below the Mar 21 - Sep 21 sun line on the BONNEVILLE sunchart.

9. *Collectors are oriented within 40 degrees E or W of due south with a tilt angle of 10 to 35 degrees; or 41 to 90 degrees W, roof pitch of 4/12 or less, with a tilt angle of 10 to 20 degrees*.

   To ensure adequate exposure to average incident solar radiation, the solar collectors must be oriented within 40 degrees E or W of due south with a tilt angle of 10 to 35 degrees; or within 41 to 90 degrees W on a roof with a pitch of 4/12 or less with a tilt angle of 10 to 20 degrees. If there are multiple banks of collectors, a combination of these orientations and tilts may be used. East facing collectors shall not be considered acceptable.

10. *Collector headers are horizontal or slightly tilted toward the inlet.*

    To allow pool water to drain properly from the collectors, the collector headers shall be mounted horizontally. If any slight tilt in the header run is desired or necessitated, the pitch shall be toward the inlet. Header orientation parallel to roof slope (i.e., riser tubes oriented horizontally) is not allowed. It is recommended the piping between collectors and drain valves be pitched a minimum 1/8 inch per foot.

11. *Collector rows are plumbed so pool water enters a lower corner and exits the opposite upper corner of each row.*

    To facilitate proper solar heating, each row of solar collectors shall be plumbed to cause the pool water to flow diagonally upward through the collectors, i.e., the water enters a lower corner of the row of collectors and exits from the opposite upper corner of the row of collectors to the pool. For optimal system efficiency, it is recommended that the pool water supply piping be connected to the farthest lower collector inlet header. This keeps the solar heated water return line as short as possible, reducing heat loss.

12. *If system has multiple rows of collectors mounted on one or more sloped surfaces, all rows are plumbed in parallel and the plumbing from all individual rows returns to a common high point before final return to the pool.*

    To ensure all collectors in the system receive a proportionate share of water volume and flow rate thereby producing optimal solar heating, all rows of collectors shall be plumbed in parallel and the hot water return from each row shall be plumbed to a common high point before final return to the pool.

13. *If system has multiple rows of collectors mounted in saw tooth configuration on a level surface, rows are plumbed in parallel and a means for balancing flow rate is provided and the system flow rate is balanced.*

    If the solar pool heating system has multiple rows of collectors mounted on a level surface on racks one behind the other in "saw tooth" configuration, a common high point for the hot water return lines may not be possible. In this situation, all rows of collectors shall be plumbed in parallel and an alternative means for balancing the flow rate through the rows shall be provided, and the system flow rate shall be balanced.

    The preferred method to achieve balanced flow rate through all rows of collectors in saw tooth configuration on a level surface is to design and install the system so that the sum of feed and return piping lengths for each row of collectors are equal.

    An alternative method to achieve balanced flow rate is to install a ball valve on the inlet to each row of collectors and a well-type thermometer fitting and thermometer on the outlet from each row of collectors. While the system is in solar heating operation mode, flow to each row of collectors is regulated with the ball valve, and system flow rate is balanced when the outlet temperature from each row is equal. To avoid tampering and/or damage to these balancing components, it is recommended that when the flow rate has been balanced, the ball valve positions are marked and (if possible) the handles from the ball valves and the thermometers are removed and stored for future use to re-balance the system.

    Another alternative method uses ball valves as above, and instead of using in line well-type thermometers, a laser thermometer is used to measure temperature at the hot outlet of each collector row. Again, system flow rate is balanced when the outlet temperature from each row is equal.

14. *Collector mounting is per manufacturers specifications*.

To comply with warranty provision and ensure long-term integrity of the system, collectors shall be mounted according to manufacturers specifications and any BONNEVILLE requirements specific to the system.

To prevent uplift due to high winds and to ensure collector array stability, collector hold-down straps, if specified and supplied by the collector manufacturer, shall be installed across each row of collectors and secured between each collector in accordance to manufacturer's recommendations. Vinyl covered metallic straps are recommended. If non-metallic straps are used, it is recommended they be run continuously across each row of collectors (i.e., no splices between collectors) and be knotted at the ends to keep them from pulling out over time.

15. *Framework will resist deterioration.*

To maintain structural integrity of the support system and the collectors, all mounting components, racking materials, and collector framework shall resist deterioration. Wood shall be pressure treated and steel shall be primed and painted to prevent rust. Joiners and fasteners shall be of similar, non-reactive metals of adequate strength.

16. *Corrosion between dissimilar metals has been avoided in all structural components and mounting hardware.*

Like or compatible metals shall be used to prevent corrosion between dissimilar metals.

17. *Collectors that use a protruding flange connection at the headers have flashing installed between each flange and roof surface.*

To prevent deterioration of the roof surface during expansion and contraction of the collectors, collectors that use a protruding flange connection at the headers shall have properly installed flashing between each header joint flange connection and the roof surface.

18. *All roof penetrations are permanently sealed*.

To prevent roof damage and water leaks, all roof penetrations shall be permanently sealed. Pipes shall be run through properly installed roof jacks. Lag screw and spanner bolt penetrations shall be sealed in and around the holes and over the entire fastening assembly with a 20-year plus rated sealant compatible with the roofing material.

System Plumbing/Piping

19. *Piping between collectors and the pool mechanical system is schedule 40 PVC material and is a minimum diameter 1.5" up to 40 gallons/minute and 2" up to 80 gallons/minute.*

    To reduce friction losses in the plumbing, minimize the load on the pool pump and achieve adequate system flow, the piping between the collectors and the pool mechanical system shall be schedule 40 PVC material and is a minimum diameter 1.5" up to 40 gallons/minute and 2" up to 80 gallons/minute.

20. *System flow rate is compatible with total number and size of collector panels.*

    To achieve optimum solar heating results, the collector panels shall have adequate flow rate through each panel. Follow manufacturers recommendations or these general guidelines:

Collector size	Minimum flow rate*	Maximum flow rate*
4’ x 12'	3.0 gpm	10.0 gpm
4’ x 10'	2.5 gpm	10.0 gpm
4’ x 8'	2.5 gpm	10.0 gpm

* Flow rates are per panel.

    For example, using the general guidelines, a simple system with 8, 4’x10’ collectors needs to have a total system flow rate between the minimum of 20 gpm (8 x 2.5 gpm), and the maximum of 80 gpm (8 x 10.0 gpm).

21. *Piping runs are adequately supported*.

    To ensure correct system operation and to prevent damage due to trapped pool water in the pipes, piping runs shall be well supported using appropriate materials.

22. *There are no leaks in the system plumbing.*

    All plumbing and connections are installed properly to ensure no fluid leakage in the system.

Valves, Controls, and Meters

23. *Isolation ball valves are installed enabling bypass of solar collection loop.*

    To ensure the solar collection loop can be isolated from the backup pool heater in an emergency or for servicing the system, and to protect solar loop components from freezing if pool circulation system is ever operated during potential freezing periods (either to heat the pool with an auxiliary heater or as a means of protecting the circulation equipment), a ball valve shall be installed on each the supply and return collector piping to enable bypass of the solar collection loop.

24. *Drain valves are installed on solar side of isolation valves at the lowest point on the collector inlet and outlet piping.*

    To ensure complete drainage of pool water from the collectors and piping prior to freezing conditions, manual drain valves shall be installed on the solar side of the isolation ball valves and located at the lowest point on both the inlet and outlet piping to the collectors.

25. *Flow meter is provided and installed per manufacturers specifications*.

    To enable monitoring of the water flow rate in the system, a flow meter and any associated plumbing required for its proper operation shall be installed according to manufacturers specifications in an easily visible location.

    To minimize the need to maintain or replace the flow meter, it is possible to provide a means of removing the flow meter and plugging its port in the piping when it is not in use to monitor the flow rate. If this is done, the plug in the piping shall be water tight and able to withstand system-operating pressures.

26. *A thermometer is installed in the return line from the collectors and prior to the auxiliary pool heater.*

    To monitor the temperature of the solar pre-heated water, a thermometer shall be installed between the solar collectors and the auxiliary pool heater.

27. *Vacuum relief valve(s) is/are installed on the upper collector header(s).*

    To allow a break in vacuum, thus enabling water in the collectors to return to the pool when the motorized valve has diverted the flow past the collector array, a vacuum relief valve shall be installed at the upper collector header opposite the hot water return outlet. If the hot water return lines from multiple rows of collectors are plumbed to a common high point before final return to the pool (Specification 3.C.12.), only one vacuum relief valve is required at the common high point. If multiple rows of collectors are mounted on racks in sawtooth configuration, and the upper headers are not connected with common pipe, then a separate vacuum relief valve shall be installed for each row of collectors.

28. *A motorized three-way valve is installed after the pool filter in the supply piping to the collectors and is powered by a differential temperature controller.*

    To allow the solar system to be operated only when the panels have reached sufficient temperature to add heat to the pool, and avoid cooling the pool during periods of insufficient sun, a motorized three-way valve powered by a differential temperature controller shall be installed. To ensure proper operation and drainage of the collectors and piping, the 3-way valve shall be installed on the supply piping to the collectors and after the pool filter. (The common port of the 3-way valve shall connect to the filter outlet.)

29. *A check valve is installed between filter and 3-way valve.*

    A check valve shall be installed between the filter and the solar 3-way valve to prevent any backwash from the filter to the pool when the solar collectors drain. It is recommended the check valve be of the clear plastic type to enable visible verification of its function. It is also recommended to use a check valve with unions to facilitate servicing and/or replacement of the valve.

30. *Controller is set for desired pool temperature, mounted within 6 ft. of the pool mechanical equipment and is hard-wired or plugged into nearest outlet with the wiring securely attached. If plugged into an outlet, the plug is labeled per BONNEVILLE specifications.*

    To ensure correct system operation the differential controller shall be set for the desired pool temperature high-limit. To allow for monitoring and servicing of the system, the controller shall be mounted within 6 ft. of the motorized 3-way valve, hard-wired (recommended) or plugged into nearest outlet with the wiring securely attached to parts of the system or adjacent walls or ceiling. If the controller is plugged into an outlet, the plug shall be labeled per BONNEVILLE specifications.

31. *Sensors are placed correctly and attached securely.*

    To ensure accurate operation of the automatic controls, sensors shall be placed correctly and attached securely. The solar sensor shall be exposed to the same environment (sun angle, orientation, wind, etc.) as the collectors, ideally next to and near the top of the collectors. The pool water temperature sensor shall be installed in direct contact with the pool water, as provided or recommended by the controller manufacturer, and shall be installed after the pool filter and before the motorized 3-way valve.

32. *Sensor wire is rated for outdoor use, has good connections, and is protected from weather and high temperatures.*

    To ensure correct system operation, the sensor wiring connections shall be permanently joined using crimp-type connectors and then sealed with silicone sealant. The wire shall not come in contact with hot piping or metals, shall be UV protected and rated for exterior use, and shall be protected (as much as possible) from weather and high temperatures. Any sensor wire to be run underground shall be continuous (no splices) and shall be rated for direct burial or run within conduit.

33. *All valves, gauges and instruments are labeled per BONNEVILLE specifications.*

    To identify and describe the purpose and operation of specific devices in the system, all valves, gauges, and instruments near the pool mechanical equipment shall be labeled. Permanent tags shall be used incorporating BONNEVILLE approved descriptions that include the following:
    a. Name/identification of the valve, gauge, or instrument.
    b. Purpose of the valve, gauge, or instrument.
    c. Operation of the valve, gauge, or instrument.

4. REFERENCES

- Swimming Pool Solar Heating Systems Installation Manuals for:

  AquaSol
  Aquatherm
  FAFCO
  Heliocol
  Solar Industries
  Sunstar

- Manual for A Solar Thermal Seminar, California Solar Industries Association (1991)

- Solar Heating for Swimming Pools, Florida Conservation Foundation (1980)

- Pool Collector Thermal Performance Ratings, Florida Solar Energy Center

ENERGY STAR Homes Northwest Certification Requirements

Single Family Homes

BOP 1

Natural Gas Fired Furnaces & Electric Heat Pumps

Builder Option Packages (BOPs) are a prescriptive method for labeling new homes ENERGY STAR. All requirements of the BOP shall be met in order to qualify a home for ENERGY STAR Homes Northwest certification and verified by a ENERGY STAR Homes Northwest Verifier. Additional details are contained in the ENERGY STAR Homes Northwest Specification. Local code requirements apply where they are more stringent. Trade-off options are detailed in the ENERGY STAR Homes Northwest Technical Compliance Options.

Insulation			
Ceiling		R-38	Flat or vaulted.
Wall		R-21	R-19 is option with advanced framing techniques.
Floors Over Unconditioned Space		R-30	Insulation in floor joist cavity. Perimeter insulation not allowed.
Slab Floors	Unheated	R-10 Perimeter	Applies to all concrete slab floors above or below grade. R-5 thermal break at slab edge. Perimeter insulation shall be installed for a distance of 2 feet vertical, horizontal, or combined distance. In areas east of the Cascade mountains, 4 feet is recommended.
	Heated Radiant	R-10 Full Slab	
Basement Wall		R-19	Below grade walls can extend up to 24 inches above grade.
Windows & Doors			
Glazing	Windows	U-0.35	
	Skylights	U-0.50	Skylight area shall not exceed 5% of heated floor area.
	Max. Glazing Area	21% of Heated Floor Area	Combined window and skylight area. Up to 1% of heated floor area exempt.
Doors		R-5	One door up to 28 ft^2 exempt.
Ducts			
Insulation		R-8	Ducts inside heated space exempt
Sealing		Mastic	Cloth duct tapes not allowed.
Max. Leakage		<0.06 CFM per ft^2 Floor **OR** 75 CFM Total @ 50 Pa	All forced air heating and cooling system ducts shall be installed according to ENERGY STAR Homes Northwest Specifications for sizing and leakage. Performance testing is required.
Ventilation & Air sealing			
Ventilation System		Exhaust Ventilation	Local code requirements are deemed to satisfy this requirement.
Envelope tightness		7.0 ACH @ 50 Pa	Local code requirements for air sealing are deemed to satisfy this requirement.
Heating & Cooling Equipment			
Gas Furnace		90 AFUE	Installed according to ENERGY STAR Homes Northwest Specifications for sizing, controls, airflow and refrigerant charge. Performance testing is required.
Heat Pump		8.0 HSPF / SEER 13	
Air Conditioner		SEER 13	
Water Heating			
Natural Gas	? 60 gal	0.61	
	? 60 gal	0.60	
Electric	All sizes	0.93	
Appliances & Lighting			
Appliances		ENERGY STAR Qualified	Applies to built-in appliances only.
Lighting		ENERGY STAR Qualified	A minimum of 50% of sockets to be either ENERGY STAR bulbs, fixtures, or both

ENERGY STAR Homes Northwest Certification Requirements

Single Family Homes

BOP 2

Zonal Electric, Propane & Oil Furnaces[1]

Builder Option Packages (BOPs) are a prescriptive method for labeling new homes ENERGY STAR. All requirements of the BOP shall be met in order to qualify a home for ENERGY STAR Homes Northwest certification and verified by an ENERGY STAR Homes Northwest Verifier. Additional details are contained in the ENERGY STAR Homes Northwest Specification. Local code requirements apply where they are more stringent. Trade-off options are detailed in the ENERGY STAR Homes Northwest Technical Compliance Options.

Insulation			
Ceiling		R-38	Flat or vaulted.
Wall		R-21 + 2.5 sheath	R-21 is option with advanced framing techniques.
Floors Over Unconditioned Space		R-30	Insulation in floor joist cavity. Perimeter insulation not allowed.
Slab Floors	Unheated	R-10 Perimeter	Applies to all concrete slab floors above or below grade. R-5 thermal break at slab edge. Perimeter insulation shall be installed for a distance of 2 feet vertical, horizontal, or combined distance. In areas east of the Cascade mountains, 4 feet is recommended.
	Heated Radiant	R-10 Full Slab	
Basement Wall		R-19	Below grade walls can extend up to 24 inches above grade.
Windows & Doors			
Glazing	Windows	U-0.30	
	Skylights	U-0.50	Skylight area shall not exceed 5% of heated floor area.
	Max. Glazing Area	21% of Heated Floor Area	Combined window and skylight area. Up to 1% of heated floor area exempt.
Doors		R-5	One door up to 28 ft^2 exempt.
Ducts			
Insulation		R-8	Ducts inside heated space exempt.
Sealing		Mastic	Cloth duct tapes not allowed.
Max. Leakage		<0.06 CFM per ft^2 Floor **OR** 75 CFM Total @ 50 Pa	All forced air heating and cooling system ducts shall be installed according to ENERGY STAR Homes Northwest Specifications for sizing and leakage. Performance testing is required.
Ventilation & Air sealing			
Ventilation System		Central ventilation with 70% heat recovery	
Envelope tightness		2.5 ACH @ 50 Pa	Air tightness in this path must be verified by blower door test before certification is granted.
Heating & Cooling Equipment			
Propane Furnace		80 AFUE	Installed according to ENERGY STAR Homes Northwest Specifications for sizing, controls, airflow and refrigerant charge. Performance testing is required.
Water Heating			
Natural Gas	? 60 gal	0.61	
	? 60 gal	0.60	
Electric	All sizes	0.93	
Appliances & Lighting			
Appliances		ENERGY STAR qualified	Applies to built-in appliances only.
Lighting		ENERGY STAR qualified	A minimum of 50% of sockets to be either ENERGY STAR bulbs, fixtures, or both

[1] Requirements apply to homes heated with unit heaters, electric baseboards, fan-forced, radiant or other zonal controlled, ductless, electric resistance systems. Ducted, forced-air electric furnaces are not allowed.